

Characterization of MWC (Municipal Waste
Combustion) Ashes and Leachates from MSW
(Municipal Solid Waste) Landfills
Monofills, and Co-Disposal Sites. Volume 2

NUS Corp., Pittsburgh, PA

Prepared for

Environmental Protection Agency, Washington, DC

Oct 87





Characterization of MWC Ashes and Leachates from MSW Landfills, Monofills, and Co-Disposal Sites

Volume II of VII
Leachate Baseline Report:
Determination of Municipal
Landfill Leachate
Characteristics

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DETERMINATION OF MUNICIPAL
LANDFILL LEACHATE CHARACTERISTICS
VOLUME II OF VII**

Prepared for

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TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
1.0 INTRODUCTION	1-1
1.1 PURPOSE	1-1
1.2 BACKGROUND INFORMATION	1-1
1.3 REPORT ORGANIZATION	1-2
2.0 LITERATURE REFERENCES	2-1
2.1 INTRODUCTION	2-1
2.2 WISCONSIN DEPARTMENT OF NATURAL RESOURCES SPECIAL REPORT	2-1
2.3 SOBOTKA & CO. REPORT	2-2
2.4 TEXAS A & M UNIVERSITY REPORT	2-3
2.5 LITERATURE LIMITATIONS	2-4
3.0 CHEMICAL CHARACTERISTICS OF LEACHATE IN MUNICIPAL SOLID WASTE LANDFILLS	3-1
3.1 INTRODUCTION	3-1
3.2 INDICATOR PARAMETER OBSERVATIONS	3-6
3.2.1 Dissolved Solids	3-6
3.2.2 Suspended Solids	3-7
3.2.3 Organics	3-8
3.2.4 pH	3-9
3.2.5 Alkalinity	3-10
3.2.6 Hardness	3-11
3.3 MAJOR CONTAMINANTS	3-12
3.3.1 Nitrogen	3-12
3.3.2 Phosphorus	3-13
3.3.3 Chloride	3-13
3.3.4 Sulfur	3-13
3.3.5 Calcium	3-14
3.3.6 Magnesium	3-14
3.3.7 Sodium	3-15
3.3.8 Potassium	3-15
3.3.9 Iron	3-16
3.3.10 Manganese	3-16
3.4 INORGANIC CONSTITUENTS	3-17
3.4.1 Primary Drinking Water Standards	3-17
3.4.1.1 Arsenic	3-19
3.4.1.2 Barium	3-19
3.4.1.3 Cadmium	3-20
3.4.1.4 Chromium	3-20
3.4.1.5 Lead	3-21
3.4.1.6 Mercury	3-22
3.4.1.7 Selenium	3-22
3.4.1.8 Silver	3-22

TABLE OF CONTENTS (CONTINUED)

3.4.1.9	Fluoride	3-23
3.4.2	Other Priority Pollutant Inorganics	3-23
3.4.2.1	Antimony	3-23
3.4.2.2	Beryllium	3-23
3.4.2.3	Copper	3-25
3.4.2.4	Cyanide	3-25
3.4.2.5	Nickel	3-26
3.4.2.6	Thallium	3-26
3.4.2.7	Zinc	3-27
3.4.2.8	Asbestos	3-27
3.4.3	Other Inorganic Contaminants	3-27
3.4.3.1	Aluminum	3-28
3.4.3.2	Boron	3-28
3.4.3.3	Molybdenum	3-30
3.4.3.4	Cobalt and Vanadium	3-30
3.4.3.5	Tin, Titanium, and Yttrium	3-31
3.4.4	Sobotka Literature Data	3-31
3.5	TRACE ORGANICS	3-31
3.5.1	Introduction	3-31
3.5.2	Halogenated Ethers and Aliphatics	3-43
3.5.3	Phthalate Esters	3-45
3.5.4	Phenols	3-45
3.5.5	Monocyclic and Polycyclic Aromatics	3-46
3.5.6	Polychlorinated Biphenyls	3-47
3.5.7	Pesticides and Herbicides	3-47
3.5.8	Sobotka Organic Literature Data	3-48
3.5.9	Texas A & M Organic Literature Data	3-48
3.6	SUMMARY	3-48

REFERENCES	R-1
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APPENDICES

A	Range Graphs and Median Frequency of Occurrence	A-1
	Histograms	
B	Wisconsin Case History Information	B-1

TABLES

<u>NUMBER</u>		<u>PAGE</u>
3-1	Wisconsin Landfills with Leachate Analysis Results Included In This Report	3-2
3-2	Contaminant Concentration Ranges in Leachate Reported In The Literature	3-4
3-3	Numerical Standards for Primary Drinking Water Standards	3-18
3-4	Numerical Standards for Other Priority Pollutant Inorganics	3-24
3-5	Summary of Results for Other Inorganic Contaminants	3-29
3-6	Sobotka Report: Inorganic Data	3-32
3-7	Analytical Results of Priority Pollutant Organic Compounds Detected In Wisconsin Leachates	3-41
3-8	Sobotka Report: Organic Data from 44 Case Studies	3-49
3-9	Concentration of Selected Organic Compounds Identified In Municipal Landfill Leachate or Groundwater Plume	3-58
3-10	Contaminant Concentration from Leachate of Three Municipal Landfills	3-63
3-11	Overall Summary from the Analysis of Municipal Solid Waste Leachates in Wisconsin	3-64
3-12	Comparison of Leachate Concentrations with Drinking Water Standards	3-66
3-13	Sobotka Report: Data Summary of Organic MSW Leachate Concentrations	3-69
3-14	Sobotka Report: Data Summary of Inorganic MSW Leachate Concentrations	3-70

FIGURES

<u>NUMBER</u>		<u>PAGE</u>
3-1	Municipal Solid Waste Landfills Included In This Report and Their Locations	3-3

ACRONYMS AND DEFINITIONS

BNA	Base-neutral and Acid Extractables
BOD	Biological Oxygen Demand
CAS	Chemical Abstract Service
CB	Chlorobiphenyl
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COD	Chemical Oxygen Demand
Codisposal	Disposal together of municipal solid wastes and municipal solid waste combustion ashes
CP	Chlorinated Phenols
DWE	Deionized Water Extraction Test Method
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
ESP	Electrostatic Precipitator
HSWA	Hazardous and Solid Waste Amendments
HWC	Hazardous Waste Combustion
LF	Landfill
MCL	Maximum Contaminant Level
Monofill	A landfill that contains only solid waste combustion ashes and residues
MSW	Municipal Solid Waste
MW	Monitoring Well
MWC	Municipal Waste Combustion
MWEP	Monofilled Waste Extraction Procedure, also known as SW-924
ND	Not Detected
NPDES	National Pollutant Discharge Elimination System
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls

ACRONYMS AND DEFINITIONS
PAGE TWO

PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
POTW	Publically Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
RDF	Refuse Derived Fuel
RPD	Relative Percent Difference
SS	Suspended Solids
SW-924	Deionized Water Extraction Test Method
TCLP	Toxic Characteristics Leaching Procedure Test Method
TDS	Total Dissolved Solids
TEF	Toxic Equivalency Factors
TNK	Total Nitrogen Kjeldahl
TOC	Total Organic Carbon
TSCA	Toxic Substances Control Act

1.0 INTRODUCTION

1.1 PURPOSE

This baseline report on municipal landfill leachate characteristics was written to provide support to the United States Environmental Protection Agency's (EPA's) study of the Subtitle D Program. The principal objective of this Phase I leachate baseline report, prepared by NUS Corporation (NUS), is to assist the EPA in developing data to evaluate the potential health and environmental effects of leachate from municipal landfills. This report summarizes existing leachate characteristic data supplied by the EPA, including concentrations of organic and inorganic parameters.

1.2 BACKGROUND INFORMATION

In 1979, EPA promulgated criteria for determining which Subtitle D (nonhazardous waste) disposal facilities pose a reasonable probability of adverse effects upon human health and the environment and therefore should be classified as "open dumps."

The Hazardous and Solid Waste Amendments (HSWA), enacted in 1984, require of the EPA the following actions: (1) to submit a report to Congress by November 8, 1987, addressing whether the Subtitle D criteria authorized by RCRA Sections 1008(a) and 4004 Criteria (40 CFR Part 257) are adequate to protect human health and the environment from groundwater contamination; (2) to recommend whether additional authorities are needed to enforce the criteria; and (3) to revise the criteria by March 31, 1988, for facilities that may receive hazardous household waste or wastes from small-quantity generators of hazardous waste.

Since 1984, concerns were raised regarding the chemical composition of leachate generated from municipal waste landfills. These concerns center on the detection of certain toxic metals and organics, and on the lack of available data for a comprehensive and defensible evaluation of the effects of leachates on human health and the environment.

1.3 REPORT ORGANIZATION

Section 2.0 discusses the literature sources used to prepare this report and their limitations. Section 3.0 contains the literature findings for organic and inorganic constituents. Appendix A contains range graphs and median frequency-of-occurrence histograms for the pollutants discussed in Section 3.0. Also included in Appendix A are three tables. Appendix B is a case-by-case list of the Wisconsin sites identified in this report. Appendix B also provides a summary of the information available regarding these sites, as obtained from the Wisconsin Department of Natural Resources Special Report.

2.0 LITERATURE REFERENCES

2.1 INTRODUCTION

The following literature references were used to compile this report.

- McGinley, P.M., and P. Kmet. Formation, Characteristics, Treatment, and Disposal of Leachate from Municipal Solid Waste Landfills. Wisconsin Department of Natural Resources Special Report, August 1, 1987.
- Sobotka & Co., Inc. Case history data compiled and reported in a July 1986 report to the U.S. EPA's Economic Analysis Branch of the Office of Solid Waste.
- Brown, K.W., and K.C. Donnelly. The Occurrence and Concentration of Organic Chemicals in Hazardous and Municipal Waste Landfill Leachate. Texas A & M University, Soil and Crop Sciences Department, College Station, Texas.

2.2 WISCONSIN DEPARTMENT OF NATURAL RESOURCES SPECIAL REPORT

The Wisconsin Department of Natural Resources report, which is the result of a 3-year effort, provides chemical characteristics of municipal solid waste leachate from 20 active Wisconsin landfills. Of significance is the fact that 14 out of 20 Wisconsin landfills sampled reported receiving industrial wastes. Some also reported receiving hazardous wastes.

According to the Wisconsin report, these 20 active landfills represent a wide variety of site designs, sizes, and operations. The report data were collected with the intent that the landfill contaminants could be identified; the range of these contaminants could be defined; and the impacts of time, site design, and site operation on leachate quality could be observed. By summarizing data from only leachate collection systems and leachate headwells, the report focused on the composition of leachate that could be leaving the base of the refuse in a full-scale, operating landfill.

The chemical results were obtained primarily from samples collected by the landfill owners, their consultants, or treatment plants treating the leachate. Occasionally, samples collected or results reported by other parties were available. Variability in results may be attributed to the fact that these samples were collected by different individuals, using different sampling and analytical procedures.

The way in which a sample was handled after collection may have a substantial impact on its chemical composition. The environment at the base of the refuse may have been considerably different from the surface, and the exposure to the atmosphere may have changed the redox potential, pH, color, and turbidity of the sample.

2.3 SOBOTKA & CO. REPORT

The information contained in the Sobotka study was to be used by the EPA's Economic Analysis Branch, a subdivision of the Office of Solid Waste. Several months of gathering literature of municipal leachate resulted in the information presented in the Sobotka report. The objectives of the Sobotka report were to gather active municipal landfill leachate data, primarily organics; characterize the releases; calculate the associated risks; and predict the cost of compliance that municipal landfill facilities may face. Data regarding municipal leachate were gathered over a period of several months from literature sources, such as the Wisconsin report, and from various state records. Data pertaining to 44 landfills were obtained. This information was collected from reference material and state records from 10 states, including the sites referenced in the Wisconsin report. The landfill locations, grouped by states, are as follows:

Eastern Alameda, California

Coffin Butte, Colorado
RPS Inc., Colorado

Litchfield, Connecticut
Shelton, Connecticut

Central, Delaware
Pigeon Point, Delaware

Perdido, Florida
South Dade, Florida
West Palm Beach, Florida
Unknown Site, Florida

Am Hoist, Minnesota
Bethel, Minnesota
Duluth, Minnesota
Koochiching, Minnesota
Lyon, Minnesota
Mecker, Minnesota
Pine Bend, Minnesota
Rochester, Minnesota

Hamm's Landfill, New Jersey
Landfill and Development, New Jersey
Ocean County Landfill, New Jersey

Killingsworth, Oregon
Riverbend, Oregon
Roseburg, Oregon
Short Mountain, Oregon

Tillamook, Washington

Dane, Wisconsin
Delafield, Wisconsin
Fond du Lac, Wisconsin
Green Bay (E), Wisconsin
Green Bay (W), Wisconsin
Janesville, Wisconsin
Marathon, Wisconsin
Muskego, Wisconsin
Omega Hills, Wisconsin
Outagamie, Wisconsin
Pheasant Run, Wisconsin
Polk, Wisconsin
Ridgeview, Wisconsin
Seven Mile Creek, Wisconsin
Superior, Wisconsin
Tork, Wisconsin
Winnebago, Wisconsin

2.4 TEXAS A & M UNIVERSITY REPORT

The Texas A & M University study was conducted by the Soil and Crop Sciences Department. This report was undertaken to compile chemical constituent and concentration data and to compare the risks associated with exposure to organic pollutants found in leachate from industrial and municipal waste landfills. The study focused on the organic constituents of landfill leachate from various sources. The data were combined to identify minimum and maximum concentrations of specific constituents found in leachate from municipal and industrial waste landfills. Data presented in this report included Texas A & M University data on three municipal landfills: Lyon Municipal Landfill, Meeker Municipal Landfill, and Rochester Landfill. Landfill locations were not given.

2.5 LITERATURE LIMITATIONS

The data contained in this baseline report have several limitations. The unknowns included sampling and handling procedures employed, analytical methods, and landfill conditions. For example, a landfill identified as receiving only municipal waste may have knowingly or unknowingly accepted industrial or hazardous waste. The ages of the landfills are also unknown. The Wisconsin report indicates that the landfills sampled were relatively young, but the other two sources do not identify the various landfill ages. The landfill design and refuse depths are also unknown. The Wisconsin report mentions that concentrations exhibited seasonal fluctuations. However, dates sampled are not given.

These three reports also do not indicate whether the leachates were pure or had been diluted by natural resources prior to sampling. Leachate freshness is also not mentioned.

The major concern in using the data from Wisconsin report regarding municipal solid waste landfill leachate is the fact that 14 out of the 20 landfills reported receiving industrial waste material.

Because of these limitations, a comparison of these literature sources has not been done. The data have been presented for reference and to provide a baseline report.

3.0 CHEMICAL CHARACTERISTICS OF LEACHATE IN MUNICIPAL SOLID WASTE LANDFILLS

3.1 INTRODUCTION

The information provided in this section regarding the chemical characteristics of leachate in municipal solid waste landfills was obtained from studies conducted by the Wisconsin Department of Natural Resources, Sobotka & Co., Inc., and Texas A & M University, as detailed in Section 2.0. Since the Wisconsin study was the most extensive of the three studies, the majority of information in this section is based on the Wisconsin report.

The Wisconsin report contains numerous references to the landfills in Wisconsin from which leachate data were obtained. Table 3-1 summarizes landfill site data and identifies, by site identification number and name, the site references used throughout the text. Figure 3-1 illustrates the locations of these sites.

Table 3-2, excerpted from the Wisconsin report, lists contaminant concentration ranges in leachate as reported in various literature sources (George, 1972; Chian and DeWalle, 1977; Metry and Cross, 1977; and Cameron, 1978) from the early 1970s to July 1986. Also included are values obtained from the Sobotka & Co. report. These data are a summary of ranges developed from the analyses of leachate seeps, contaminated surface waters, contaminated groundwaters, and from test lysimeters.

Although Table 3-2 illustrates that a fair amount of data are reported in the literature, the extreme variability of these values limits its usefulness. The values from this table are included in the various upcoming sections.

The Wisconsin study also contains numerous range graphs and median frequency-of-occurrence histograms. These figures are included in Appendix A and are referenced throughout this report.

Table 3-1 Wisconsin Landfills with Leachate Analysis Results Included in this Report.

Site Number	Name	Site Type	Total Design Volume (million cubic yards)	Principal Waste Types	Date Filling Began	Site Size (acres)
11	WMI-Lauer I	ZS		MSW, IND	pre-1960	38
307	WMI-Polk	CL	0.5	MSW	1970	9
572	Land Reclamation	ZS	9.5	MSW, IND, HAZ	pre-1970	82
611	Winnebago Co.	ZS	5.5	MSW, IND	pre-1970	94
652	Tork	R	1.5	MSW, IND	1970	38
719	Delafield	CL	1.0	MSW	1975	13
1099	WMI-Metro	ZS	9.0	MSW, IND, HAZ	pre-1970	96
1678	WMI-Omega Hills	ZS	15.0	MSW, IND, HAZ	1971	166
1739	WMI-Pasasant Run	ZS	1.6	MSW, IND	pre-1967	35
2358	Fond du Lac Co.	ZS	0.5	MSW, IND	1978	16
2484	Outagamie Co.	ZS	3.2	MSW, IND	1975	47
2568	Brown Co. West	ZS	4.0	MSW, IND	1977	50
2569	Brown Co. East	CL	6.0	MSW	1976	30
2575	WMI-Ridgeview	NA	0.8	MSW, IND	1976	17
2627	City of Superior	ZS	0.6	MSW, IND	1976	20
2680	Dane Co.	NA	1.5	MSW	1977	49
2821	Eau Claire Co.	CL	1.2	MSW	1978	24
2822	City of Janesville	CL	0.7	MSW, IND	1978	18
2892	Marathon Co.	CL	1.5	MSW, IND	1980	10
2895	WMI-Muskego	CL	1.3	MSW	1980	29

Abbreviations:

Site Types

NA: Natural Attenuation

CL: Clay Lined

ZS: Zone-of-saturation

R: Retrofit

Principal Waste Types

MSW: Municipal Solid Waste

IND: Industrial Waste

HAZ: Hazardous Waste

Source: Wisconsin Department of Natural Resources Report

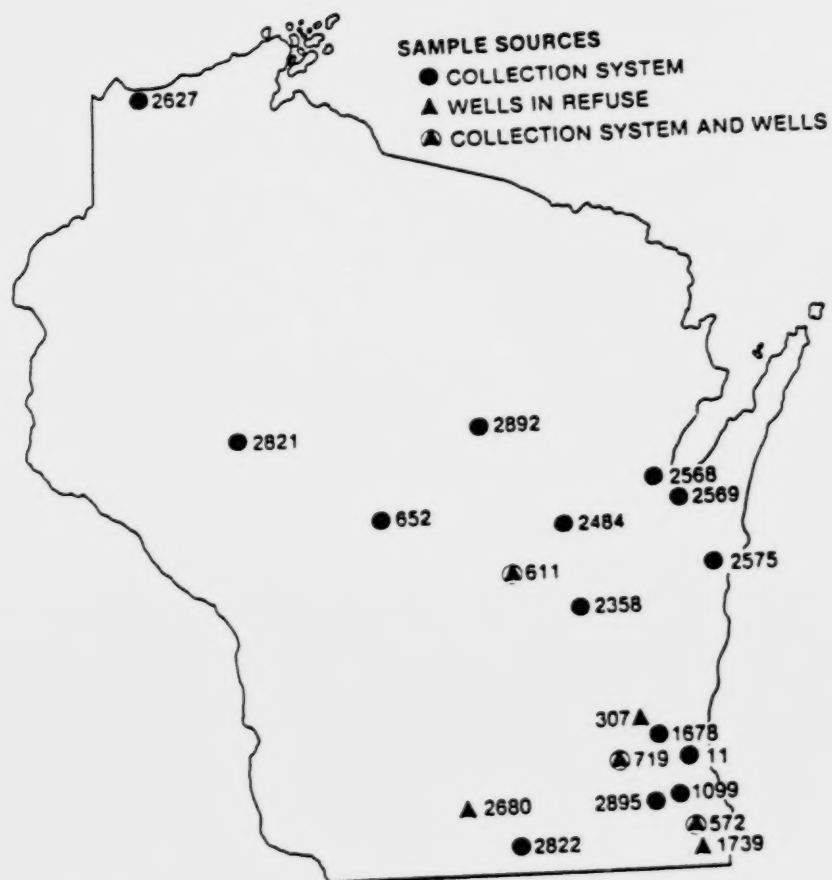


Figure 3-1 Municipal Solid Waste Landfills Included in this Report and their Locations.

Source: Wisconsin Department of Natural Resources Report

TABLE 3-2

CONTAMINANT CONCENTRATION RANGES IN LEACHATE REPORTED IN THE LITERATURE
[All Concentrations in mg/l (ppm)]

	George (1972)	Chian/ DeWalle (1977)	Metry/Cross (1975)	Cameron (1978)	Wisconsin Report (20 sites)	Sobotka Report (44 sites)
pH	3.7-8.5	3.7-8.5	3.7-8.5	3.7-8.5	5-8.9	5.4-8.0
Alkalinity	0-20,850	0-20,850	310-9,500	0-20,900	ND-15,050	0-7,375
Total Solids		0-59,200				1,900-25,873
TDS	0-42,276	584-44,900	100-51,000	0-42,300	584-50,430	1,400-16,120
Total Suspended Solids	6-2,685	10-700	13-26,500		2-140,900	28-2,835
Specific Conductance		2,810-16,800	100-1,200		480-72,500	
BOD	9-54,610	81-33,360	2,200-720,000	9-55,000	ND-195,000	7-21,600
COD	0-89,520	40-89,520	800-750,000	0-9,000	6.6-97,900	440-50,450
TOC		256-28,000			ND-30,500	5-6,884
Bicarbonate			3,260-5,730			
Hardness	0-22,800	0-22,800	35-8,700	0-22,800	52-225,000	0.8-9,380
Chlorides	34-2,800	4.7-2,467	47-2,350	34-2,800	2-11,375	120-5,475
Fluorides				0-2.13	0-0.74	0.12-0.790
Sulfates	1-1,826	1-1,558	20-1,370	0-1,826	ND-1,850	8-500
Sulfide				0-0.13		
Total-K-Nitrogen	0-1,416				2-3,320	47.3-938
NH ₃ -Nitrogen	0-1,106	0-1,106	0.2-845	0-1,106	10-1,200	11.3-1,200
Organic Nitrogen			2.4-550			4.5-78.2
NO ₃ -Nitrogen	0-1,300	0.2-10.29	4.5-18		10-250	0-50.95
Total Phosphorus	1-154	0-130			ND-234	
Ortho-Phosphorus		6.5-85	0.3-136	0-154		
Aluminum				0-122	ND-85	0.010-5.07
Arsenic				0-11.6	ND-70.2	0-0.08
Barium				0-5.4	ND-12.5	0.01-10
Beryllium				0-0.3	ND-0.36	0.001-0.01
Boron				0.3-73	0.867-13	
Cadmium		0.03-17		0-0.19	ND-0.04	0-0.1
Calcium	5-4,080	60-7,200	240-2,570	5-4,000	200-2,500	95.5-2,100
Total Chromium				0-33.4	ND-5.6	0.001-1.0
Copper	0-9.9	0-9.9		0-10	ND-4.06	0.003-0.32

TABLE 3-2
CONTAMINANT CONCENTRATION RANGES
IN LEACHATE REPORTED IN THE LITERATURE
 [All Concentrations in mg/l (ppm)]
PAGE TWO

	George (1972)	Chian/ DeWalle (1977)	Metry/Cross (1975)	Cameron (1978)	Wisconsin Report (20 sites)	Sobotka Report (44 sites)
Cyanide				0-0.11	ND-6	0-4.0
Iron	0.2-5,500	0-2,820	0.12-1,700	0.2-5,500	ND-1,500	0.22-1,400
Lead	0-5.0	<0.10-2.0		0-5.0	0-14.2	0.001-1.11
Magnesium	16.5-15,600	17-15,600	64-547	16.5-15,600	ND-780	76-927
Manganese	0.06-1,400	0.09-125	13	0.06-1,400	ND-31.1	0.03-43
Mercury				0-0.064	ND-0.01	0-0.02
Molybdenum				0-0.52	0.01-1.43	
Nickel				0.01-0.8	ND-7.5	0.01-1.25
Potassium	2.8-3,770	28-3,770	28-3,800	2.8-3,770	ND-2,800	30-1,375
Sodium	0-7,700	0-7,700	85-3,800	0-7,700	12-6,010	
Titanium				0-5.0	<0.01	
Vanadium				0-1.4	0.01	
Zinc	0-1,000	0-370	0.03-135	0-1,000	ND-731	0.01-67

All concentrations in mg/l except pH (std units) and Sp. Cond. (μ mhos/cm).

ND = Not detected

Source: Wisconsin Department of Natural Resources Report

3.2 INDICATOR PARAMETER OBSERVATIONS

3.2.1 Dissolved Solids

Dissolved solids can be measured directly as Total Dissolved Solids (TDS) or as specific conductance. There is a direct correlation between these two measurements. Occasionally, only the in-situ measurement specific conductance is reported.

Factors affecting specific conductance values of leachate include

- Runoff of water into the collection system
- Landfill operational values
- Contact of leachate with the lower layers of refuse
- Groundwater dilution
- Age of landfill

Specific conductance ranges and median values from leachate samples from 18 Wisconsin municipal waste landfills are displayed in Figure A-1, Appendix A.

These relatively high specific-conductance values for leachate reflect the highly mineralized nature of municipal solid waste leachate.

The wide variation in specific conductance of leachate between the different Wisconsin sites and even within an individual site sampled at different times reflects the tremendous variability in the overall leachate strength. This variation makes it difficult to define a typical concentration range, but emphasizes the importance of identifying the variables that affect leachate quality.

No significant reduction in specific conductance has been observed at Wisconsin landfills with time, although this is not expected, since they are still active and relatively young.

The dissolved solids content of Wisconsin leachates puts them in the high-hazard classification for irrigation waters (EPA, 1973).

**Comparison of Published Values
for Ranges of Specific Conductance ($\mu\text{mhos/cm}$)**

Chian, DeWalle	2,810-16,800
Metry, Cross	100-1,200
Wisconsin	480-72,500

3.2.2 Suspended Solids

Factors affecting leachate suspended solid values include the following:

- The degree of well development and the filtering action of the gravel pack
- Filters in leachate collection pipes
- Surface water runoff

Suspended solids analyses from 14 Wisconsin landfills are summarized in Figure A-2, Appendix A. The ranges are quite broad and reflect variability at most sites.

The suspended solids concentrations found in Wisconsin municipal solid waste (MSW) leachates are comparable to those reported in the literature for other leachates (Table 3-2).

Comparison of Published Values in mg/l (ppm)

Total Solids (mg/l)	
Chian, DeWalle	0-59,200
Sobotka	1,900-25,873
Total Dissolved Solids in mg/l (ppm)	
George	0-42,276
Chian, DeWalle	584-44,900
Metry, Cross	100-51,000
Cameron	0-42,300
Wisconsin	584-50,430
Sobotka	1,400-16,120
Total Suspended Solids in mg/l (ppm)	
George	6-2,685
Chian, DeWalle	10-700
Metry, Cross	13-26,500
Wisconsin	2-140,900
Sobotka	28-2,835

This great variation in values indicates that reporting of data in "averages" or "means" is meaningless and that data should be reported in ranges.

3.2.3 Organics

Factors affecting leachate organic concentration noted by the Wisconsin report include the following:

- Site age - The leachate's biological oxygen demand (BOD) decreases faster than the chemical oxygen demand (COD).
- A landfill's methanogenic bacterial community - This results in the depletion of easily degraded compounds, while refractory organics remain relatively inert and make the COD more resistant to change.
- Oxygen demand concentration patterns over time - This reflects some of the influences of site design and operational variations.
- BOD values - High values are usually found in the spring or summer.
- Dilution of leachate by surface water and rainwater.
- Variability over time.

The leachate BOD concentrations from 16 Wisconsin landfills are presented in Appendix A in Figure A-3. The number of samples per site ranged from 5 to 1,060, and the results were primarily reported by treatment plants that accepted the leachate. The COD ranges are presented in Figure A-4, although less extensive than the number of BOD samples. COD samples were obtained from 19 sites and were represented with 1 to 188 samples per site.

BOD values ranged from undetected to 195,000 mg/l (ppm). COD values ranged from less than 50 to 100,000 mg/l (ppm).

Comparison of Literature Values for BOD in mg/l (ppm)

George	9-54,610
Chian, DeWalle	81-33,360
Metry, Cross	2,200-720,000
Cameron	9-55,000
Wisconsin	ND-195,000
Sobotka	7-21,600

Comparison of Literature Values for COD in mg/l (ppm)

George	0-89,520
Chian, DeWalle	40-89,520
Metry, Cross	800-750,000
Cameron	0-9,000
Wisconsin	6.6-97,900
Sobotka	440-50,450

Comparison of Literature Values for TOC in mg/l (ppm)

Chian, DeWalle	256-28,000
Wisconsin	ND-30,500
Sobotka	5-6,884

ND - Not Detected

The extreme ranges of these parameters within each individual site and within different sites indicate the need to report these values in "ranges" rather than as "averages" or "means." Calculation of statistical parameters may also be meaningless.

3.2.4 pH

The following factors may affect leachate pH concentrations.

- Site conditions (nature of local soils).
- Surface water dilution/infiltrating groundwater.

- Refuse stability - Leachate pH generally rises from a low of about 5 to neutrality as the refuse stabilizes.
- Decreasing BOD - As the BOD decreases, the pH rises; this change reflects the reduction in organic acid concentration.

Figure A-5, in Appendix A, depicts the pH values of the monitored sites in Wisconsin. Evaluation of these data indicates that the overall range for pH is from 5 to 9.

The pH values reported for leachates at Wisconsin landfills were closer to neutral than pH 3.7, the value reported in the literature.

Comparison of Literature Values for pH (pH Units)

George	3.7-8.5
Chian, DeWalle	3.7-8.5
Metry, Cross	3.7-8.5
Cameron	3.7-8.5
Wisconsin	5-8.9
Sobotka	5.4-8.0

3.2.5 Alkalinity

Factors affecting leachate alkalinity concentrations include the following:

- Leachate from older stabilized fills with lower COD values had alkalinities largely attributable to the carbonate-bicarbonate system.
- Stronger COD leachates from younger fills had alkalinities derived from organic acids.
- As the refuse stabilizes and the concentrations of other parameters are reduced, the alkalinities are also expected to decrease.

The total alkalinity results from 14 Wisconsin landfills are presented in Appendix A, Figure A-6. The reported alkalinity concentrations in Wisconsin landfill leachates are well within the ranges reported as typical municipal landfill leachate.

Comparison of Literature Values for Alkalinity in mg/l (ppm)

George	0-20,850
Chian, DeWalle	0-20,850
Metry, Cross	310-9,500
Cameron	0-20,900
Wisconsin	ND-15,050
Sobotka	0-7,375

ND - Not Detected

Again, the extreme variation in values indicates the need to report data in ranges rather than as averages or means.

3.2.6 Hardness

Calcium and magnesium are the principal contributors to hardness, but iron, manganese, and possibly zinc are contributors. A plot of the range and median values for hardness from 14 Wisconsin landfills is shown in Appendix A, Figure A-7. This figure presents 404 values from collection systems and headwells.

The hardness values were much higher in leachates reported in the Wisconsin study than in published data, as were the pH values. These increased values result from the strata on which the Wisconsin sites are located.

Comparison of Literature Values for Hardness in mg/l (ppm)

George	0-22,800
Chian, DeWalle	0-22,800
Metry, Cross	35-8,700
Cameron	0-22,800
Wisconsin	52-225,000
Sobotka	0.8-9,380

3.3 MAJOR CONTAMINANTS

3.3.1 Nitrogen

The following factors affect leachate nitrogen concentration values:

- Newer sites and sites with dilute leachate have lower nitrogen concentrations.
- Deeper refuse sites tend to have higher nitrogen concentrations.

The analysis results for total-Kjeldahl-nitrogen and ammonia-nitrogen in Wisconsin landfill leachate are graphically depicted in Figures A-8 and A-9 in Appendix A. These figures show the ranges and median values for 9 and 11 sites, respectively.

The values reported for total-Kjeldahl-nitrogen, ammonia-nitrogen, and nitrate-nitrite-nitrogen are comparable to those reported for typical municipal solid waste leachate. Figure A-10 shows the range and median value for leachate nitrate nitrogen for the Wisconsin landfills.

Comparison of Literature Values in mg/l (ppm)

Total-Kjeldahl-Nitrogen	
George	0-1,416
Wisconsin	2-3,320
Sobotka	47.3-938
Ammonia-Nitrogen	
George	0-1,106
Chian, DeWalle	0-1,106
Metry, Cross	0.2-845
Cameron	0-1,106
Sobotka	11.3-1,200
Wisconsin	10-1,200
Organic-Nitrogen	
Metry, Cross	2.4-550
Sobotka	4.5-78.2
Nitrate-Nitrogen	
George	0-1,300
Chian, DeWalle	0.2-10.29
Metry, Cross	4.5-18
Sobotka	0-50.95
Wisconsin	0-250

3.3.2 Phosphorus

Figure A-11, in Appendix A, shows the range and median values for total phosphorus concentrations at 11 Wisconsin landfills. The ranges of phosphorus concentrations show that Wisconsin municipal waste leachates are generally comparable to other sites.

Comparison of Literature Values for Total Phosphorus in mg/l (ppm)	
George	1-154
Chian, DeWalle	0-130
Wisconsin	ND-234

ND - Not Detected

3.3.3 Chloride

Chloride is a common constituent of solid waste and can be found in high concentrations in landfill leachate. The ranges and median values for leachate chloride concentrations from 15 Wisconsin landfills are presented in Figure A-12, Appendix A. For most sites the concentrations are below 2,500 mg/l (ppm), and the variation within a site is generally less than a range of 1,500 mg/l (ppm).

3.3.4 Sulfur

These factors affect leachate sulfur concentrations.

- The powerful precipitating ability of sulfides probably precludes the movement of sulfide out of the landfill in leachate.

Sulfate concentrations in Wisconsin landfill leachates ranged from less than 1 to more than 1,850 mg/l (ppm). Site median values fall within a relatively narrow range of 100 to 500 mg/l (ppm). The upper end of the leachate sulfate concentration range at most Wisconsin landfills exceeded 1,000 mg/l (ppm), and many values exceeded the Secondary Drinking Water Standard of 250 mg/l (ppm). The range of sulfate concentrations from 11 Wisconsin landfills is presented in Figure A-13 in Appendix A.

3.3.5 Calcium

Calcium concentrations of municipal solid waste (MSW) leachates in Wisconsin were available from 7 sites, with a total of 9 values. The concentrations reported ranged from 200 to 2,500 mg/l (ppm), and six of the nine values were evenly distributed between 200 and 700 mg/l (ppm). The overall concentration range is in general agreement with that reported in the literature for other MSW leachates, although the literature-reported extremes of 4,000-7,000 mg/l (ppm) were never reported at Wisconsin sites.

No drinking water standard exists for calcium. Wisconsin leachates are considered very hard, based on the calcium content alone.

Comparison of Literature Values for Calcium in mg/l (ppm)

George	5-4,080
Chian, DeWalle	60-7,200
Metry, Cross	240-2,570
Cameron	5-4,000
Wisconsin	200-2,500
Sobotka	95.5-2,100

3.3.6 Magnesium

In nine samples from seven landfills, the concentration of magnesium in Wisconsin MSW leachates ranged from 120 to 780 mg/l (ppm). Most of the magnesium concentrations of leachates reported in the literature were below 1,000 mg/l (ppm), although the overall range of 17-15,600 mg/l (ppm) (Table 3-2) showed extreme values considerably in excess of leachate concentrations found in Wisconsin.

No drinking water standard has been established for magnesium, but Wisconsin leachates generally exceed environmental concentrations (aquifers and surface water).

Comparison of Literature Values for Magnesium in mg/l (ppm)

George	16.5-15,600
Chian, DeWalle	17-15,600
Metry, Cross	64-547
Cameron	16.5-15,600
Wisconsin	ND-780
Sobotka	76-927

ND - Not Detected

3.3.7 Sodium

Concentrations for sodium in Wisconsin landfills are reported in Figure A-14 in Appendix A. Sodium is the most commonly analyzed cation in Wisconsin municipal landfill leachate. Leachate concentrations ranged from 12 to 6,010 mg/l (ppm). Leachates exceeded the natural sodium concentrations in groundwater [range 0.0-107 mg/l (ppm), median 3.3 mg/l (ppm)] and surface waters [Wolf River: 2 mg/l (ppm), Lake Michigan: 4.5 mg/l (ppm)]. Primary Drinking Water Standards for sodium, based on dietary restrictions, were also exceeded 270 mg/l (ppm) (USEPA, 1976).

Comparison of Literature Values for Sodium in mg/l (ppm)

George	0-7,700
Chian, DeWalle	0-7,700
Metry, Cross	85-3,800
Cameron	0-7,700
Wisconsin	12-6,010

3.3.8 Potassium

Wisconsin leachate potassium concentrations were well in excess of the concentrations found naturally in state waters. The leachate range was from less than 20 to 2,800 mg/l (ppm).

Comparison of Literature Values for Potassium in mg/l (ppm)

George	2.8-3,770
Chian, DeWalle	28-3,770
Metry, Cross	28-3,800
Cameron	2.8-3,770
Wisconsin	ND-2,800
Sobotka	30-1,375

ND - Not Detected

3.3.9 Iron

The concentrations of iron found in leachates from Wisconsin landfills were usually in excess of the Secondary Drinking Water Standard of 0.3 mg/l (ppm). Many values were 100 to 1,000 times greater than this. They also exceed the typically encountered concentrations of iron in natural waters. Leachate iron concentrations were available from 17 Wisconsin landfills. Presented in Figure A-15 in Appendix A are 416 analysis results with 1 to 86 samples from each landfill.

Comparison of Literature Values for Iron in mg/l (ppm)

George	0.2-5,500
Chian, DeWalle	0-2,820
Metry, Cross	0.12-1,700
Cameron	0.2-5,500
Wisconsin	ND-1,500
Sobotka	0.22-1,400

ND-Not Detected

3.3.10 Manganese

Data on manganese concentrations in Wisconsin leachates are available from 11 landfills with 67 analysis results. The ranges and median histogram for these values are presented in Figure A-16.

The overall range was from undetected to 31 mg/l (ppm), although most values were between 2 and 10 mg/l (ppm). Nearly all the leachates analyzed exceeded the Secondary Drinking Water Standard of 0.05 mg/l (ppm).

Comparison of Literature Values for Manganese in mg/l (ppm)

George	0.06-1,400
Chian, DeWalle	0.09-125
Metry, Cross	13
Cameron	0.06-1,400
Wisconsin	ND-31.1
Sobotka	0.03-43

ND - Not Detected

3.4 INORGANIC CONSTITUENTS

Inorganic contaminants are broken into the following categories:

- Primary Drinking Water Standards
- Other Priority Pollutants
- Other Inorganics

It is also important to refer to the maximum concentration values established by the EPA indicating characteristics of EP toxicity. If these values are exceeded, the waste material is classified as hazardous. The values are as follows:

Arsenic	5.0 mg/l (ppm)
Barium	100.0 mg/l (ppm)
Cadmium	1.0 mg/l (ppm)
Chromium	5.0 mg/l (ppm)
Lead	5.0 mg/l (ppm)
Mercury	0.2 mg/l (ppm)
Selenium	1.0 mg/l (ppm)
Silver	5.0 mg/l (ppm)

3.4.1 Primary Drinking Water Standards

The Primary Drinking Water Standards were established by the EPA (and adopted by the State of Wisconsin), based on health considerations. The inorganic parameters for which primary drinking water standards have been established are listed in Table 3-3, along with pertinent environmental criteria. These parameters include arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and fluoride. Analysis for these parameters in leachate has varied, and routine analysis is more

TABLE 3-3

NUMERICAL STANDARDS FOR PRIMARY DRINKING WATER STANDARDS
 [All Concentrations in mg/l (ppm)]

Parameter	Drinking Water Standard (1)	USEPA 1980 Criteria for Human Health (2)	Wisconsin Water Quality Criteria (daily maximum) (3)	Maximum Concentration for Characteristic of EP Toxicity
Arsenic (As)	0.05	0.0000022	1.5	5.0
Barium (Ba)	1			100.0
Cadmium (Cd)	0.01	0.01	0.07	1.0
Chromium (Cr)	0.05	170(+ 3)	11.7	5.0
Lead (Pb)	0.05	0.05	1.07	5.0
Mercury (Hg)	0.002	0.000144	0.002	0.2
Selenium (Se)	0.01	0.01	1.03	1.0
Silver (Ag)	0.05	0.05	0.008	5.0
Fluoride (F)	1.4-2.4			
Nitrate (NO ₃ ⁻)	10			

Sources:

- (1): U.S. Public Health Service, 1962.
- (2): USEPA, 1980, criteria based on both water and organism ingestion.
- (3): DNR files, 1984, for protection of Wisconsin warm-water fish and aquatic life (water hardness 100 mg/l-CaCO₃)

Wisconsin Department of Natural Resources Report

the exception than the rule. The following subsections discuss the results available. The only other inorganic primary drinking water standard is for nitrate, which is examined in Section 3.3.1.

3.4.1.1 Arsenic

Precipitation and absorption of ions may be a significant mechanism controlling the presence of arsenic in landfill leachate.

In Figure A-17, Appendix A, 112 arsenic analysis results from 13 Wisconsin landfills are presented. Of the 13 sites, 3 (1099, 1678, and 1739) had values that exceeded the Primary Drinking Water Standard of 0.05 mg/l (ppm). All of these sites accepted municipal solid waste and industrial waste. Two also accepted hazardous waste material. All other sites had median leachate arsenic concentrations below 0.02 mg/l (ppm). The concentration of arsenic found in Wisconsin leachates is generally equal to or lower than the few concentrations reported in the literature for other sites.

Comparison of Literature Values for Arsenic in mg/l (ppm)

Cameron	0-11.6
Wisconsin	ND-70.2
Sobotka	0-0.08

ND - Not Detected

3.4.1.2 Barium

Barium concentrations in Wisconsin landfill leachates exceeded the detection limits at 8 of the 11 sites where barium was analyzed. Two of the sites, where barium was not detected, had detection limits within the commonly detected range. Overall, barium concentrations found in Wisconsin landfill leachates ranged from nondetected to 12.5 mg/l (ppm), based on the analysis of 73 leachate samples. The range for each site is shown in Figure A-18.

Leachate barium concentrations exceeded the Primary Drinking Water Standard of 1 mg/l (ppm) at Sites 11, 1099, 1678, 1739, 2822, and 2895. Site 2895 accepted only municipal solid waste. All others reported accepting industrial waste, with two sites

also accepting hazardous waste (see Table 3-1 for site descriptions and Figure 3-1 for site locations).

Comparison of Literature Values for Barium in mg/l (ppm)

Cameron	0-5.4
Wisconsin	ND-12.5
Sobotka	0.01-10

ND - Not Detected

3.4.1.3 Cadmium

The cadmium analysis results of leachates from 16 Wisconsin landfills are presented in Figure A-19, where the ranges and median values are indicated. Results from 158 analyses were available, ranging from 1 to 31 results at each site.

Leachates from most sites exceeded the Primary Drinking Water Standard of 0.01 mg/l (ppm). Most leachates analyzed were within the range of 0.01 to 0.1 mg/l (ppm).

Comparison of Literature Values for Cadmium in mg/l (ppm)

Chian, DeWalle	0.03-17
Cameron	0-0.19
Wisconsin	ND-0.4
Sobotka	0-0.1

ND - Not Detected

3.4.1.4 Chromium

In Figure A-20, the ranges and medians for leachate total chromium analysis from 16 Wisconsin landfills are presented.

The overall concentrations of chromium in the leachates ranged from undetected to 5.6 mg/l (ppm). The majority of these values were above the Primary Drinking Water Standard of 0.05 mg/l (ppm). Leachates exceed the typical wastewater concentration of 0.125 mg/l (ppm). Leachates also exceed typical Wisconsin groundwater levels.

Comparison of Literature Values for Chromium in mg/l (ppm)

Cameron	0-33.4
Wisconsin	ND-5.6
Sobotka	.001-1.0
ND - Not Detected	

3.4.1.5 Lead

The results of 142 Wisconsin landfill leachate lead analyses from 15 sites were reported and are presented in Figure A-21.

The leachate lead concentrations ranged from nondetectable to 12.6 mg/l (ppm). These concentrations are considerably in excess of concentrations typically found in the environment. The Primary Drinking Water Standard is 0.05 mg/l (ppm).

The median lead concentrations are arranged in a frequency-of-occurrence histogram in Figure A-21. It is apparent that new sites (2892) and sites with relatively weak leachates (0011) have lead concentrations typically less than 0.1 mg/l (ppm). Newer sites with medium-strength leachates (2895) may have lead concentrations from 0.1 - 0.3 mg/l (ppm), and sites with high-strength leachates and a history of industrial waste co-disposal (1678) may have leachate lead concentrations typically greater than 0.3 mg/l (ppm) and potentially as high as 10 mg/l (ppm). Table 3-1 lists site descriptions and Figure 3-1 depicts their location.

Typical municipal wastewaters, according to the Wisconsin Report, have lead concentrations of 0.050 to 0.100 mg/l (ppm). Landfill leachates in Wisconsin have 5 to 10 times this amount.

Comparison of Literature Values for Lead in mg/l (ppm)

George	0-5.0
Chian, DeWalle	<0.10-2.0
Cameron	0-5.0
Wisconsin	0-14.2
Sobotka	0.001-1.11

3.4.1.6 Mercury

Although mercury typically has the lowest concentrations of any Primary Drinking Water Standard in leachate, its great toxicity makes its evaluation important.

The concentration ranges of mercury in Wisconsin landfill leachate are presented as ranges and medians in Figure A-22. The Primary Drinking Water Standard for mercury is 0.002 mg/l (ppm), and this level was exceeded or attained at least once by leachates from six sites.

Site median values show that although mercury concentrations can exceed the Primary Drinking Water Standard, typical concentrations, ranging from 0.0001 to 0.001 mg/l (ppm), are below this standard.

Comparison of Literature Values for Mercury in mg/l (ppm)

Cameron	0-0.064
Wisconsin	ND-0.01
Sobotka	0-0.02

ND - Not Detected

3.4.1.7 Selenium

Selenium analysis results for Wisconsin landfill leachates are presented in Figure A-23. Analysis of leachate for selenium was performed on 121 samples from nine landfills in Wisconsin.

Concentration ranges extended to 1.85 mg/l (ppm). It is apparent that selenium concentrations do not typically exceed the Primary Drinking Water Standard of 0.01 mg/l (ppm). Two sites whose medians did were 572 and 1739 (Table 3-1; Figure 3-1). Both of these sites are older and accepted industrial waste material. Site 572 also accepted hazardous wastes. Because selenium is more soluble as the pH increases, most soils containing selenium are alkaline.

3.4.1.8 Silver

The concentrations of silver found in Wisconsin landfill leachates are presented in Figure A-24. The overall concentrations detected ranged to 0.196 mg/l (ppm), and

three sites had values at or above the Primary Drinking Water Standard of 0.05 mg/l (ppm).

3.4.1.9 Fluoride

Leachate fluoride concentrations for the Wisconsin landfills ranged from nondetectable to 0.74 mg/l (ppm). These leachate fluoride concentrations never exceeded the Primary Drinking Water Standard of 1.4-2.4 mg/l (ppm).

3.4.2 Other Priority Pollutant Inorganics

The inorganic compounds on the priority pollutant list include eight constituents in addition to those previously described. These eight are antimony, beryllium, copper, cyanide, nickel, thallium, zinc, and asbestos. Although these compounds are recognized as toxic, many of their environmental impacts are still being evaluated.

Table 3-4 provides a summary of these parameters. Concentrations of the parameters in environmental criteria and treatment systems are shown. A discussion of each contaminant follows.

3.4.2.1 Antimony

Antimony analysis of MSW leachates was available for six Wisconsin sites with 1-21 values each site, for a total of 76 analyses. They ranged from nondetected to 3.19 mg/l (ppm), as shown in Figure A-25. The individual values were distributed throughout this range, with site medians ranging from nondetected to 0.56 mg/l (ppm).

The USEPA (1979) has proposed a maximum concentration in water of 0.146 mg/l (ppm) for protection of human health. Where detected, all antimony concentrations exceeded this level.

3.4.2.2 Beryllium

The overall range encountered at the Wisconsin landfills was from nondetected to 0.36 mg/l (ppm), as shown in Figure A-26.

TABLE 3-4

NUMERICAL STANDARDS FOR OTHER PRIORITY POLLUTANT INORGANICS
 [All Concentrations in mg/l (ppm)]

Parameter	Secondary Drinking Water Standard (1)	USEPA 1980 Criteria for Human Health (2)	Wisconsin Water Quality Criteria (daily maximum) (3)
Antimony (Sb)		0.146	13
Beryllium (Be)		0.000068	1.7
Copper (Cu)	1	1	0.026
Cyanide (Cn)		0.2	0.095
Nickel (Ni)		0.0134	2.7
Thallium (Tl)		0.013	1.41
Zinc (Zn)	5	5	0.46

Sources:

- (1): U.S. Public Health Service, 1962
- (2): USEPA, 1980, criteria based on both water and organism ingestion
- (3): Department of Natural Resources (DNR) files, 1984, for protection of Wisconsin warm-water fish and aquatic life (water hardness 100 mg/l-CaCO₃)

Wisconsin Department of Natural Resources Report

The median beryllium concentrations in leachates from all sites were below 0.005 mg/l (ppm). The proposed drinking water standard for beryllium is 0.000087 mg/l (ppm).

Comparison of Literature Values for Beryllium in mg/l (ppm)

Cameron	0-0.3
Wisconsin	ND-0.36
Sobotka	0.001-0.01

ND - Not Detected

3.4.2.3 Copper

Copper analyses are available for 17 Wisconsin sites with 1-25 values each. The 138 values are plotted in range and median graphs in Figure A-27. Overall copper concentrations detected ranged from less than 0.01 mg/l (ppm) to 4.06 mg/l (ppm). Copper values in Wisconsin aquifers range from 0.0-2.4 mg/l (ppm).

Comparison of Literature Values for Copper in mg/l (ppm)

George	0-9.9
Chian, DeWalle	0-9.9
Cameron	0-10
Wisconsin	ND-4.06
Sobotka	0.003-0.32

ND - Not Detected

3.4.2.4 Cyanide

Cyanide analyses of MSW leachates were reported for eight Wisconsin sites. A total of 86 values were reported, with the number of values ranging from 1-17 per site. The values varied from less than 0.001 to 0.99 mg/l (ppm) (Figure A-28). The median cyanide concentrations are shown in a frequency-of-occurrence histogram in Figure A-28. Site 572 had a median concentration of 0.25 mg/l, and the other sites all had median concentrations below 0.1 mg/l (ppm). Site 572 (Table 3-1; Figure 3-1) is an older site and has reported accepting municipal, industrial, and hazardous wastes. Two sites exceeded the maximum allowable cyanide concentration in drinking water of 0.2 mg/l (ppm).

Comparison of Literature Values for Cyanide in mg/l (ppm)

Cameron	0-0.11
Wisconsin	ND-6
Sobotka	0-4.0

ND - Not Detected

3.4.2.5 Nickel

Leachate nickel analysis results were available for 16 Wisconsin landfills with 1 to 24 values each, for a total of 133 analyses. The overall range detected was from less than 0.01 to 7.5 mg/l (ppm). Leachates that contained maximum concentrations of nickel exceeding 1 mg/l (ppm) came from three codisposal sites, (572, 1099, 1678) and from a site containing primarily municipal refuse (2575). Table 3-1 lists important details about these sites and Figure 3-1 shows their location. The ranges of leachate nickel are shown in Figure A-29.

The U.S. EPA (1980) has proposed a water quality standard of 0.013 mg/l (ppm) for nickel. Nearly all leachate analyses exceeded this level.

Comparison of Literature Values for Nickel in mg/l (ppm)

Cameron	0.01-0.8
Wisconsin	ND-7.5
Sobotka	0.01-1.25

ND - Not Detected

3.4.2.6 Thallium

Thallium analyses of municipal solid waste leachates were available for six Wisconsin sites with 1-19 values each, for a total of 70 values. The overall range encountered was from less than 0.001 to 0.78 mg/l (ppm), with individual analyses widely spread throughout this range (Figure A-30).

The USEPA (1979) proposed a drinking water standard for thallium of 0.013 mg/l (ppm). Several leachates exceed this value.

3.4.2.7 Zinc

Zinc analysis results of Wisconsin leachates were available for 17 sites with 1-30 values each for a total of 158 values. The overall range detected was from less than 0.01 to 731 mg/l (ppm). The individual site ranges and median values have been plotted in Figure A-31.

The Secondary Drinking Water Standard is 5 mg/l (ppm). Leachate zinc concentrations frequently exceed the Secondary Drinking Water Standard and always exceed the aquatic life criterion [0.07 mg/l (ppm)].

Comparison of Literature Values for Zinc in mg/l (ppm)

George	0-1,000
Chian, DeWalle	0-370
Metry, Cross	0.03-135
Cameron	0-1,000
Wisconsin	ND-731
Sobotka	0.01-67

ND - Not Detected

3.4.2.8 Asbestos

Results of the one leachate analysis for asbestos fibers at Site 2822 revealed nondetectable concentrations (1.03×10^6 fibers per liter).

3.4.3 Other Inorganic Contaminants

In addition to the parameters previously discussed, several municipal solid waste leachates in Wisconsin have been analyzed on a nonroutine basis for a wide variety of other potential contaminants. Some parameters have only been analyzed at one site on a one-time basis, whereas others may have been analyzed several times.

Considering the variability demonstrated by other parameters for which there are considerably more data, the probable variability of these contaminants in different leachates is high.

A summary of the test results for all parameters discussed in this section is presented in Table 3-5 along with comparative information from the literature. A brief discussion of each contaminant follows.

3.4.3.1 Aluminum

Aluminum analysis of leachates was performed at five Wisconsin landfills on a total of nine samples. Three Wisconsin landfills, 572, 2569, and 2822 (Table 3-1; Figure 3-1), reported leachate aluminum concentrations below 1 mg/l (ppm). Site 2569 reports accepting only municipal waste; Site 2822 reports accepting municipal and industrial wastes; and Site 572 reports accepting municipal, industrial, and hazardous wastes. Another site, 307, reported leachate aluminum concentrations of 4.5 and 5.6 mg/l (ppm); and a third site, 1099, reported a concentration of 85 mg/l (ppm). This site accepted municipal, industrial, and hazardous wastes.

These leachate aluminum concentrations at Wisconsin landfills are comparable to the leachate aluminum concentration range of 0-122 mg/l (ppm) reported by Cameron (1978).

Comparison of Literature Values for Aluminum in mg/l (ppm)

Cameron	0-122
Wisconsin	ND-85
Sobotka	0.010-5.07

ND - Not Detected

A maximum aluminum concentration in drinking water supplies has not been established, but a 5 mg/l (ppm) limit has been recommended by the EPA (1973) for livestock and irrigation waters. Only one leachate substantially exceeded this limit--the report for Site 1099 [85 mg/l (ppm)]. Site 1099 data (Table 3-1) indicates this site accepted municipal, industrial, and hazardous wastes.

3.4.3.2 Boron

Seven landfills in Wisconsin have analyzed leachate for boron, and a total of 15 analytical results are available. Overall boron concentrations ranged from

TABLE 3-5

SUMMARY OF RESULTS FOR OTHER INORGANIC CONTAMINANTS
 [All Concentrations in mg/l (ppm)]

Parameter	Wisconsin Landfill Leachates		Range in Other Leachates
	Number of Samples	Range of Concentrations	
Aluminum (Al)	9	0.01-85	0-122
Boron (B)	15	0.867-13	0.3-73
Cobalt (Co)	1	<0.25	0.004-0.07
Molybdenum (Mo)	7	0.01-1.43	0-0.52
Tin (Sn)	3	0-0.08	0
Titanium (Ti)	1	<0.01	0-5
Vanadium (V)	1	0.01	0-1.4
Yttrium (Y)	1	<0.017	

Source: Wisconsin Department of Natural Resources Report

nondetected to 13 mg/l (ppm). Site maximums were commonly from 4 to 8 mg/l (ppm).

A drinking water standard has not been proposed for boron, but the EPA (1973) has recommended a maximum boron content in livestock waters of 5 mg/l (ppm) and in irrigation waters of 0.75 mg/l (ppm). The two leachates tested were at the livestock limit and were well in excess of the irrigation limit.

3.4.3.3 Molybdenum

Molybdenum analysis was performed on leachates from three Wisconsin landfills. Five results from Site 1678 (which accepted municipal, industrial, and hazardous wastes, as indicated in Table 3-1) and one each from Sites 11 (accepted municipal and industrial wastes) and 572 (accepted municipal, industrial, and hazardous wastes) are available. The overall range of molybdenum concentrations in these leachates was from 0.01 to 1.43 mg/l (ppm). This concentration range is similar to, although somewhat larger than, the range reported by Cameron (1978) for leachates of 0 to 0.52 mg/l (ppm).

The concentrations exceeded the recommended levels for short-term irrigation waters of 0.05 mg/l (ppm) (EPA, 1973).

Comparison of Literature Values for Molybdenum in mg/l (ppm)

Cameron	0-0.52
Wisconsin	0.01-1.43

3.4.3.4 Cobalt and Vanadium

The values detected for these elements in a one-time analysis of leachate from a Wisconsin site were less than 0.25 mg/l (ppm) for cobalt and 0.01 mg/l (ppm) for vanadium. These elements are considered moderately mobile in soils.

Comparison of Literature Values for Vanadium in mg/l (ppm)

Cameron	0-1.4
Wisconsin	0.01

3.4.3.5 Tin, Titanium, and Yttrium

Three analytical results for tin and one each for titanium and yttrium were available from Wisconsin municipal solid waste landfill leachates. Of these elements, only tin was present above detection limits. No data on other municipal solid waste leachates or municipal wastewaters was available with which to compare these results.

Comparison of Literature Values for Titanium in mg/l (ppm)

Cameron	0-5.0
Wisconsin	<0.01

3.4.4 Sobotka Literature Data

Table 3-6 summarizes the inorganic leachate concentration values Sobotka & Co., Inc., obtained through its literature search. The sites are listed in Section 2.3.

3.5 TRACE ORGANICS

3.5.1 Introduction

Leachate samples from nine Wisconsin landfills were analyzed for priority pollutant organic compounds. In Table 3-7, the priority pollutant organics detected in Wisconsin leachates are listed. The analytical results for these sites and the frequency of detection in leachates from other states is also shown.

From Table 3-7 it is apparent that approximately one half of the priority pollutant organic compounds were present in leachates and wastewaters. Generally, the volatiles, aromatic solvents, phenols, and phthalate esters were present. Few of the polycyclic aromatic hydrocarbons and none of the nitrosamines were detected. Pesticides and PCBs were also not commonly detected.

Within each of the major classes of organic compounds, the physical properties and nature of the toxicities can be similar. The results of the organic analyses have been divided into major classes reflecting these similarities. These groups are

Table 3-6 Sobotka Report: Inorganic Data From 44 Case Studies
(all concentrations in mg/l)

CONSTITUENT	PIGDEON POINT DE	CENTRAL DE	LITCHFIELD CT	SWELTON CT	EASTERN ALAMEDA CA
pH	7.17	6.2	6.4		7.8
Total solids					
Total suspended solids	51.55	310			
Total dissolved solids	4761	7914.5		1408	1400
Total alkalinity	3090			766	970
Biological oxygen demand	117.25	2290		7	
Chemical oxygen demand	1110	2410	4120	440	
Total organic carbon	450 ^a	850			-5
Total Kjeldahl nitrogen	427.5				
Total nitrogen		504.5			
Ammonia	279	324.75		11.7	
Nitrite		0.2	0.307	0.01	
Nitrate	0.74	0.2	3.6	0.3	0.55
Organic nitrogen		78.2			
Sulfate					40
Fluoride					0.79
Chloride		695	300	440	270
Cyanide		0.004	0	-0.305	
Aluminum					
Arsenic	0.02	0.01	0		-0.001
Barium	0.28		0.5		0.2
Cadmium	0.02	0.02	0.012	0.005	-0.0001
Total Chromium	0.15	1.19	0.015	0.301	-0.02
Copper		0.05	0.05	0.025	-0.05
Iron	8.65	590	250	24.4	0.22
Lead	0.09	0.3	0.05	0.05	-0.001
Magnesium	155.5	30.5			76
Manganese	0.68			0.82	3.2
Mercury	0.0004	0.0004	0.005		-0.0001
Nickel		0.54	0.04	0.05	
Selenium	0.01	0.005	0.02		-0.001
Sodium				133	200
Zinc	0.08	67	0.12	0.67	-0.21
Total arsenophate				0	
Hardness					0.9
Calcium	75.5				30
Potassium				20	45
Antimony		0.47			
Beryllium		0.01			
Silver	0.02	0.02	0.022		-0.01
Thallium		0.08			
Conductivity		3987	7840	2700	2500
Nitrate + Nitrite					
Boron					
Cobalt			0.04		
Hexavalent chromium					

Negative values indicate detection limits for compounds not detected
Blanks indicate no analysis was performed

Source: Sobotka Report



Table 3-6 continued

CONSTITUENT	WEST PALM BEACH FLA	SOUTH DADE FLA	PERDIDO FLA	UNKNOWN SITE FLA	RFS INC. CO
pH				7.55	6.78
Total solids					
Total suspended solids					
Total dissolved solids	4325			7506.5	4910
Total alkalinity				7375	
Biological oxygen demand					
Chemical oxygen demand	507.5	3867		2944	2100
Total organic carbon				600	1000
Total kjeldahl nitrogen				958	
Total nitrogen					
Ascorbic	180	822.5		921.5	40
Nitrite					
Nitrate	0.02			50.55	
Organic nitrogen		62.5			
Sulfate	55.5			120	5
Fluoride	0.25				
Chloride	492.5			5475	180
Cyanide					
Aluminum					
Arsenic	-0.01			0.02	
Barium	0.215				
Cadmium	-0.005	0.0007		-0.007	
Total Chromium	0.01	0.02			
Copper					
Iron				0.12	
Lead	0.01	0.07	1.05	5.77	
Magnesium			927	-0.01	
Manganese			1.06		
Mercury	0.0005	0.006			
Nickel			1.07	0.74	
Selenium	0.005				
Sodium			929		
Zinc			1.09	1.86	
Total phosphate				8.7	
Hardness					
Calcium					
Potassium			977		
Antimony			1.1		
Beryllium					
Silver	-0.01				
Thallium					
Conductivity	3246				
Nitrate + Nitrite		0.69			5000
Boron					
Cobalt					
Hexavalent chromium					

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

CONSTITUENT	COFFIN BUTTE CO	KILLINGS- WORTH OR	RIVER- BEND OR	ROSEBURG OR	SHORT MOUNTAIN OR
pH	7.3	7.38	6.69	6.7	8
Total solids					
Total suspended solids					
Total dissolved solids					
Total alkalinity	1344	2370	4600	1034	591
Biological oxygen demand	2330				161
Chemical oxygen demand	4080	720	6875	460	472.5
Total organic carbon			6730		175
Total kjeldahl nitrogen					36
Ammonia	60	32.2	1200	14.4	50
Nitrite	0.05				
Nitrate	0.77				
Organic nitrogen					
Sulfate	237	122	346	105	3.7
Fluoride					
Chloride	302	404.7	1488.9	258	480
Cyanide					
Aluminum					
Arsenic					
Barium					
Cadmium					-0.001
Total Chromium					
Copper					0.005
Iron	47.5	7.58	210	1.7	2.85
Lead					-0.005
Magnesium	122				91.5
Manganese	41.75				
Mercury					
Nickel					0.04
Selenium					
Sodium	250				
Zinc	5.19				0.11
Total phosphate	0.42				
Hardness	1936	927.65	5780	1200	765
Calcium	516				126
Potassium	131.75				
Antimony					
Beryllium					
Silver					
Thallium					
Conductivity	4884	5423.5	10900	2660.5	3068
Nitrate + Nitrite				-0.02	0.02
Boron					
Cobalt					
Hexavalent chromium					

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

CONSTITUENT	New Jersey			
	TILLAMOOK MA	NJ0051128 OCEAN COUNTY LANDFILL NJ	NJ0053449 HAMM S LANDFILL NJ	NJ0022509 LANDFILL & DEVELOPMENT NJ
pH	7.2	5.6		6.6
Total solids	-			
Total suspended solids	-	292		
Total dissolved solids	-			
Total alkalinity	-			9008
Biological oxygen demand	-	9044		
Chemical oxygen demand	-	15820		2550
Total organic carbon	-			11900
Total Kjeldahl nitrogen	-			
Total nitrogen	-			
Ammonia	-	152		226
Nitrite	-			
Nitrate	-			
Organic nitrogen	-			
Sulfate	-			
Fluoride	-			57
Chloride	169			6.4
Granide	-			77
Aluminum	-			0.02
Arsenic	0.02			0.08
Barium	0.74			0.425
Cadmium	0.02			0.04
Total Chromium	0.05			0.02
Copper	-			0.15
Iron	14.1			220
Lead	0.14			0.04
Magnesium	-			
Manganese	0.57			2.4
Mercury	0.0007			0.0008
Nickel	-			0.2
Selenium	0.01		0.01	0.01
Sodium	871			744
Zinc	1.8		0.65	0.85
Total phosphate	-	2.13		
Hardness	568			
Calcium	-			
Potassium	-			
Antimony	-			
Beryllium	-		0.005	
Silver	0.01			0.05
Thallium	-		0.08	
Conductivity	-			
Nitrate + Nitrite	0.12			
Boron	-			
Cobalt	-			
Hexavalent chromium	-			

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

CONSTITUENT	Wisconsin				
	2484 OUTAGAMIE WI	2568 GREEN BAY WEST (DECASTER) WI	2569 GREEN BAY EAST (DECLEENE) WI	2375 RIDGVIEW WI	2627 SUPERIOR WI
pH	7.18	6.4	6.45	6.3	7.1
Total solids			5860		9300
Total suspended solids	268		156	650	
Total dissolved solids	7676	4178	9300		
Total alkalinity	6380	1504	2770		4790
Biological oxygen demand	1645	3048	8236	12000	
Chemical oxygen demand	2119	3365	8570		5220
Total organic carbon	486				235
Total kjeldahl nitrogen	309				
Total nitrogen					
Ammonia	336		228		209
Nitrite					-0.2
Nitrate	-0.1		0		-0.2
Organic nitrogen					
Sulfate	255				
Fluoride					
Chloride	1400	940	1040	-4	
Cyanide					
Aluminum			-1		-0.01
Arsenic	-0.01				
Barium	-2				
Cadmium	-0.03		-0.05	0.05	0.009
Total Chromium	1		-0.1	0.4	0.05
Copper	0.1		-0.1	0.1	0.12
Iron	15.85	4	29.5	395	
Lead	0.3		-0.5	-0.5	0.25
Magnesium	200		210.5		
Manganese	1.4		2.97		
Mercury	-0.001				0.0002
Nickel	0.18		-0.1	1.25	0.1
Selenium	-0.05				
Sodium		321	508		
Zinc	2		0.42	10	3.13
Total phosphate	1.08		1.31	4.6	
Hardness	2240	1825	3670		
Calcium	321		425		
Potassium	560		46.5	21	
Antimony					
Beryllium					
Silver	-0.03				
Thallium					
Conductivity	15485	4390	7635		6800
Nitrate + Nitrite					
Boron					
Cobalt					
Hexavalent chromium				-0.05	

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

Wisconsin

CONSTITUENT	307 POLK WI	611 WINNEBAGO WI	652 TORK WI	719 DELAFIELD WI	1759 PHEASANT RUN WI
pH	5.7	6.5	6.32	7.21	6.9
Total solids	16790			10790	
Total suspended solids	1410	28	140	365	1905
Total dissolved solids	16120	2190		12546	
Total alkalinity	5350	2650		5750	2470
Biological oxygen demand	21600	740	630	5860	577.5
Chemical oxygen demand	50450	3520	1156	7370	2990
Total organic carbon		427			
Total kjeldahl nitrogen				710	
Total nitrogen					
Ammonia		34		517	
Nitrite				0.112	
Nitrate	1.38	1.4		0.21	
Organic nitrogen				4.5	
Sulfate	155			500	
Fluoride					
Chloride	885	350		980	759
Cyanide			0.005		
Aluminum	5.07				
Arsenic		-0.01	0.002		0.07
Barium	0.3				2.59
Cadmium		-0.01	0.015	-0.01	0.05
Total Chromium	0.53	-0.06	0.06		0.23
Copper	0.32	-0.04	0.02	-0.01	0.3
Iron	359	2.1		246	169
Lead		-0.01	0.1		1.11
Magnesium	547	120			
Manganese	25.9	0.93		3.1	
Mercury		-0.001	0.0006		-0.0002
Nickel		-0.07	0.14	0.2	0.2
Selenium			-0.02		0.09
Sodium	1198			12	
Zinc	54	-0.01	0.15	1.5	47.7
Total phosphate		0.52		2.48	1.31
Hardness	4160	1481	3590		1050
Calcium	1979	200			
Potassium	1375	75			
Antimony			0.56		
Beryllium			0.008		
Silver			0.009		-0.05
Thallium			0.1		
Conductivity	8183	3540	5804	10150	5000
Nitrate + Nitrite					
Boron	7.13				
Cobalt					
Hexavalent chromium			-0.003		

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

CONSTITUENT	Wisconsin				
	2680 DANE WI	2821 SEVEN MILE CREEK WI	2822 JANESVILLE WI	2892 MARATHON WI	2895 MUSKESG WI
pH	5.4	5.9	6.15 25875	6.58	
Total solids			2875		275
Total suspended solids		5400			
Total dissolved solids		2000		950	
Total alkalinity	4290		3500	1150	2760
Biological oxygen demand	33500	15500	9520	2875	2540
Chemical oxygen demand					
Total organic carbon				48.61	479.5
Total kjeldahl nitrogen					
Total nitrogen					
Ammonia	170			25.08	410
Nitrite				0.75	0.14
Nitrate					
Organic nitrogen		210	200	140	
Sulfate					
Fluoride		700	300	180	
Chloride	1770		0.083		0.02
Cyanide			0.01		
Aluminum		-0.02	0.001	-0.005	0.015
Arsenic					
Barium		-10	5	-0.01	0.6
Cadmium		-0.1	0.07	-0.01	0.015
Total Chromium		-0.1	0.05	0.01	0.13
Copper		-0.1	0.09	0.05	0.058
Iron	500	1400	150	66.2	
Lead		-0.5	0.07	0.015	0.17
Magnesium	780	150			1.2
Manganese		22	1.25		0.001
Mercury		-0.02		-0.0005	0.001
Nickel		-0.1	0.02	-0.01	0.001
Selenium		-0.02			0.001
Sodium	1200	570			1.95
Zinc		2.4	0.84	0.03	117.18
Total phosphate				1780	
Hardness	9780	3900			
Calcium	2100	350			107.5
Potassium	400	150			0.009
Antimony			-0.002		0.001
Beryllium			-0.01		0.008
Silver		-0.05			
Thallium			0.11		0.004
Conductivity	15100	7900	9250	2840	
Nitrate + Nitrite					4.05
Boron		5.1			
Cobalt					
Hexavalent chromium					

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

CONSTITUENT	Wisconsin		Minnesota			
	572 LR WI	2358 FOND DU LAC WI	-	BETHEL MN	KOOCHICHIKING MN	ROCHESTER MN
pH	6.7	6.6	-	7.4		5.9
Total solids			-	1900		
Total suspended solids	330		-			
Total dissolved solids			-			10100
Total alkalinity	2875		-	470		
Biological oxygen demand	3000		-	1700		
Chemical oxygen demand	5708	2060	-			
Total organic carbon	1123		-			6834
Total kjeldahl nitrogen	47.3		-			
Total nitrogen			-			
Amonia			-			727
Nitrite			-	-0.01		
Nitrate	0.125		-			
Organic nitrogen			-			
Sulfate	8.4	108	-	22		
Fluoride	0.74		-	0.12		
Chloride	923	795	-	120		975
Cyanide	0.25		-			
Aluminum	0.31		-			
Arsenic	0.002		-			0.021
Barium	0.225		-			
Cadmium	0.05		-			
Total Chromium	0.64		-			0.11
Copper	0.17		-			0.07
Iron	211	46.65	-			1200
Lead	0.03		-			0.27
Magnesium	312.1		-			
Manganese	0.5		-			42
Mercury	0.0002		-			
Nickel	1.08		-			
Selenium	0.02		-			
Sodium	771.4	580.5	-			
Zinc	22		-			12
Total phosphate	3.8		-			
Hardness	2096	1845	-			
Calcium	693.4		-			
Potassium			-			
Antimony			-			
Beryllium	-0.002		-			
Silver	0.008		-			
Thallium			-			
Conductivity	10005	6375	-	2700		12400
Nitrate + Nitrite			-			
Boron	4.6		-	0.99		
Cobalt	-0.25		-			
Hexavalent chromium			-			

Negative values indicate detection limits for compounds not detected

Table 3-6 continued

Minnesota

CONSTITUENT	PINE BEND MN	MECKER MN	LYON MN	DULUTH MN	AM HOIST MN
pH				6.8	
Total solids					
Total suspended solids					
Total dissolved solids					
Total alkalinity					
Biological oxygen demand					
Chemical oxygen demand					
Total organic carbon				110	1100
Total kjeldahl nitrogen					
Total nitrogen					
Ammonia				62.3	200
Nitrite					
Nitrate					
Organic nitrogen					
Sulfate				17	
Fluoride					
Chloride				310	990
Cyanide					
Aluminum					
Arsenic	0.012				
Barium					
Cadmium	-0.01			0.0005	0.02
Total Chromium	0.013				
Copper	0.05			0.02	0.12
Iron	475			46	200
Lead	0.12			0.008	
Magnesium					
Manganese	0.26				120
Mercury					
Nickel	0.06				0.47
Selenium					
Sodium					
Zinc	0.15			0.13	24
Total phosphate					
Hardness					
Calcium					
Potassium					320
Antimony					
Beryllium					
Silver					
Thallium					
Conductivity				5400	
Nitrate + Nitrite				0.14	
Boron				0.52	
Cobalt					
Hexavalent chromium					

Negative values indicate detection limits for compounds not detected

Table 3-7 Analytical Results of Priority Pollutant Organic Compounds Detected in Wisconsin Landfills

Sample Source	Site ID	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130</
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Table 3-7 continued

Compound	Site ID										Upper States Landfills									
	11	11	11	572	611	1099	1099	1099	1099	1099	1678	1678	1678	1678	1678	1678	1678	1678	1678	1678
	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)
Sample Source	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)	CS (M)
Sampling Date	Mar 82	Oct 82	Jan 81	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80	Dec 80
Concentrations in parts per billion (micrograms per liter)																				
Polycyclic Aromatics	1.8	<10	1.9	<100	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	<10	<10	<10	<100	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
2-Chloronaphthalene	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Phenols	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Phenolate Esters	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Bis(2-ethylhexyl)phthalate	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Di-n-butyl phthalate	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Diethyl phthalate	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Miscellaneous	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
Resolins	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425
	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425	425

Sources:

- (1) Spitzer, 1986. Maximum concentration in leachates from three Oregon landfills
 (2) Shuckow et al., 1982. Maximum concentration in leachate from the Mid-South landfill, Boulder Colorado
 (3) Sauer and Cline, 1983. Maximum concentration in leachates from the Midwestern landfill
 (4) Robinson et al., 1976. Compounds detected in groundwater beneath the Norman landfill in Delaware
 (5) Demille and Olson, 1981. Compounds detected in leachate from the Army Creek landfill in Delaware
 (6) Shuckow et al., 1982. Compound detected in groundwater near the Oak/Sage landfill in Michigan

Notes:

All concentrations in parts per billion (micrograms per liter)

CS indicates sample from leachate collection system

ND indicates sample from leachate beneath

0 denotes compound detected at concentration below detection limit

1 denotes compound detected above detection limit

- Halogenated ethers and aliphatics
- Phthalate esters
- Phenols
- Monocyclic and polycyclic aromatics
- Polychlorinated biphenyls (PCBs)
- Pesticides and herbicides

The emphasis in the following sections is on those chemicals detected in leachates from the Wisconsin landfills.

3.5.2 Halogenated Ethers and Aliphatics

Of the organic compounds on the priority pollutant list, 33 are chlorinated or brominated ethers and short-chain hydrocarbons. Most of these compounds are volatile, persistent, and nonaccumulative and many are carcinogenic. Nearly two-thirds, or 21, of these compounds have been identified in the leachates from Wisconsin landfills.

Methylene chloride was the most commonly identified of these compounds, detected in 19 of 24 leachate samples. Typical concentrations of methylene chloride were 50-5,000 mg/l (ppm). Methylene chloride is a known laboratory contaminant and, since data were not validated, one must use caution when drawing conclusions regarding the presence of this contaminant in leachate.

At Site 1099 (Table 3-1), the methylene chloride value was 20,000 mg/l (ppm). This is an older site where municipal, industrial, and hazardous materials were disposed.

Methyl chloride, methyl bromide, and chloroform were detected in several Wisconsin leachates. These compounds may also be carcinogenic and hence have exceeded the human health criterion, where discovered.

Another commonly detected halogenated aliphatic in both Wisconsin and literature leachates is 1,1-dichloroethane. Thirteen of the twenty-three leachate samples had detectable concentrations of 1,1-dichloroethane. Concentrations ranged from nondetectable to 6,300 mg/l (ppm) in Wisconsin leachates. The high value of

6,300 mg/l (ppm) was in a leachate from Site 572 (Table 3-1). Typical concentrations, where detected, were from 100-750 mg/l (ppm).

The 1,2 isomer of dichloroethane was detected in only three Wisconsin leachates. The high concentration was 11,000 mg/l (ppm). 1,2-dichloroethane is a suspected carcinogen and, as such, any detectable concentration exceeds the ambient-water-quality criteria level. The concentration associated with a 10^{-6} risk is less than 1 mg/l (ppm), a concentration level exceeded in the three leachates. The high value of 11,000 mg/l (ppm) was obtained from Site 2822, which is an industrial and municipal waste landfill (Table 3-1).

Several other chlorinated, two-carbon, organic compounds were frequently detected in Wisconsin landfill leachates. 1,2-Trans-dichloroethylene, trichloroethylene, and tetrachloroethylene were detected in 13 of 22, 11 of 23, and 9 of 23 leachate samples, respectively. All of these compounds are suspected carcinogens, and as such, they exceed the ambient criterion concentration for human consumption. EPA's 10^{-6} factors were also exceeded where these compounds were detected, and where they were not found, the EPA risk concentration was below the reported detection limit. The maximum concentrations of these compounds found in Wisconsin leachates ranged from 2,760 mg/l (ppm) for trans-1,2-dichloroethylene and 1,120 mg/l (ppm) for trichloroethylene, to 620 mg/l (ppm) for tetrachloroethylene.

Several other halogenated aliphatics were found in nearly a third of the leachate samples from Wisconsin landfills. These compounds, 1,1,1-trichloroethane and 1,2-dichloropropane, were also both found in Minnesota leachates, and trichloroethane was found in one of three Oregon leachates (Table 3-7).

The concentrations of 1,1,1-trichloroethane ranged from nondetectable to 24,000 mg/l (ppm), but that was the only analysis above 700 mg/l (ppm). 1,2-Dichloropropane was found at concentrations ranging to 86 mg/l (ppm) and in several of the samples where it was detected at concentrations below the detection limit of 10 mg/l (ppm).

The other chlorinated aliphatics and ethers detected in at least one Wisconsin leachate are shown in Table 3-7 with their concentration ranges and a comparison to other leachates. Where detected, these compounds are found in concentrations

that do not exceed the ambient water quality criterion for noncarcinogenic effects. In instances where the compound is carcinogenic, it exceeds the criterion level of zero, where detected.

3.5.3 Phthalate Esters

Five of the six phthalate esters on the EPA priority pollutant list were detected in leachates from Wisconsin landfills. One of these phthalates, diethyl phthalate, was detected in 16 of 23 leachate samples. Three other commonly detected phthalates, bis(2-ethylhexyl), di-n-butyl, and butyl benzyl, were detected in 6 of 23, 4 of 23, and 3 of 23 leachate samples, respectively.

Phthalates are common laboratory contaminants, and since the data evaluated here were not validated, use of these data should be made with caution.

The concentrations of phthalate esters found in Wisconsin leachates never exceeded the ambient water quality criteria established to prevent toxic effects in humans. Water quality criterion levels were typically 100 to 1,000 times the concentrations found in Wisconsin leachates.

3.5.4 Phenols

The priority pollutant analysis of leachates from Wisconsin landfills has identified four of the 11 phenols and cresols on the list in Wisconsin leachates. Chloro-, nitro-, and methylphenols were identified in several leachates, whereas phenol itself was found in 16 of 23 leachate samples. The substituted phenols were never found at concentrations in excess of 500 mg/l (ppm) and were always less than the EPA criteria for human health. The concentrations of phenol itself in Wisconsin leachates ranged as high as 11,300 mg/l (ppm), a concentration level exceeding the EPA human health criterion. Higher values of phenol in leachate were found at Site 1678 (Table 3-1), the industrial waste codisposal site. At Site 2895 (Table 3-1), a municipal waste landfill, phenol concentrations from 39 to 350 mg/l (ppm) were detected.

In addition to the priority pollutant analysis for specific phenols, total phenols were determined in leachates from eight landfills in Wisconsin. These data are presented

in Table A-1. Overall the total phenol concentration ranged from nondetected to 234 mg/l (ppm), although typical values ranged from 1 to 20 mg/l (ppm).

3.5.5 Monocyclic and Polycyclic Aromatics

Of the 33 aromatic compounds on the priority pollutant list, ten were detected in leachates from Wisconsin. Most of these were monocyclic aromatics, and the only polycyclic aromatics detected were naphthalene and chloronaphthalene.

Aromatic compounds detected in at least one fourth of the leachates analyzed were benzene, chlorobenzene, 1,4-dichlorobenzene, isophorone, and toluene. Table 3-7 shows the analytical results of leachates from Wisconsin landfills, including both the range of concentrations and frequency of detection of all these compounds.

Toluene, benzene, and isophorone were commonly detected aromatic compounds. Benzene, a carcinogen, exceeded the ambient water quality standard wherever it was detected.

The other aromatic compounds in Wisconsin leachates that exceeded the ambient water quality criterion were ethylbenzene and the rarely found nitrobenzene. Naphthalene, the only polycyclic aromatic compound detected frequently in Wisconsin leachates, was found in 7 of 23 leachate samples. There is no information on naphthalene concentrations in other states' leachates, although the concentrations in Wisconsin leachates ranged to 68 mg/l (ppm). Several sites in Wisconsin detected naphthalene but at concentrations less than the detection limit. The apparent concentrations are shown in Table 3-7.

The more common aromatic solvents found in leachates from Wisconsin were those commonly detected in several leachates (Table 3-7). In addition, xylenes were detected frequently in leachates from landfills in Minnesota and Oregon. Little information on xylene concentrations in Wisconsin leachates was available, although xylene was found in leachates from Sites 2568 (municipal and industrial wastes; Table 3-1) and 2569 (municipal waste only), the only sites for which it was analyzed.

The maximum concentrations of priority pollutant aromatic compounds in Wisconsin leachates usually exceeded the maximums found in other states, a fact

which may be due to the very contaminated leachate at several sites and the availability of more data.

3.5.6 Polychlorinated Biphenyls

In Table A-2, the results of PCB analysis for Wisconsin leachates are shown. Seven PCB isomers are on the priority pollutant list, and total PCB analysis has been reported by several other landfills not in conjunction with a priority pollutant examination.

Only one Wisconsin leachate (Site 1099, which accepted municipal, industrial, and hazardous waste materials; Table 3-1) revealed a detectable concentration of a PCB isomer of 2.8 mg/l (ppm) for PCB-1016.

Because aqueous transport is the primary means of movement of leachate out of landfilled refuse, the low aqueous solubility and strong absorption onto sediments would be expected to minimize the movement of PCBs. That, in conjunction with the lack of abundance of PCBs, is probably the primary mechanism controlling its concentration in the leachate.

3.5.7 Pesticides and Herbicides

The results of leachate analysis for pesticides and herbicides are broken into three categories, which reflect similarities in the composition of these compounds. The major classifications are chlorinated hydrocarbon insecticides, organ-phosphorus insecticides, and chlorophenoxy herbicides. Table A-2 shows these groupings and the members of these groups for which leachate analysis results are available.

Pesticides were never detected in Wisconsin leachates except for one analysis from Site 2822, which accepted municipal and industrial waste (Table 3-1) and which showed 4.6 mg/l (ppm) of delta-BHC. The herbicide 2,4-D was found in two leachate samples from Sites 572 and 1099--both of which accepted municipal, industrial, and hazardous waste material--at concentrations of 7 and 1,800 mg/l (ppm), respectively.

3.5.8 Sobotka Organic Literature Data

Table 3-8 summarizes the organic leachate concentration data Sobotka & Co., Inc., obtained through its literature search. As indicated in Section 2.3, data were obtained from 44 sites in 10 states.

3.5.9 Texas A & M Organic Literature Data

Tables 3-9 and 3-10 summarize the data obtained from the Texas A & M University study. These data provide a comparison of the types and quantities of organic chemicals detected in three municipal landfill leachates.

The main site pollutants for each individual site were as follows:

- Lyon Municipal Landfill: Ethanol and 1-butanol
- Meeker Municipal Landfill: Methyl ethyl ketone and 1,1-dichloroethane
- Rochester Municipal Landfill: Ethanol, butanol, methyl ethyl ketone, and 2-propanol

The locations of these landfills were not identified. Table 3-9 identifies and lists the concentrations of numerous organic compounds identified in municipal leachate or groundwater plume. Table 3-10 summarizes organic contaminant concentrations from the leachate of three municipal landfills.

3.6 SUMMARY

An examination of leachate quality from 20 Wisconsin landfills has shown, in agreement with reported findings in the literature, that municipal landfill leachate is contaminated with highly variable concentrations of a wide variety of inorganic and organic constituents.

In Table 3-11, the range of contaminants found in Wisconsin landfill leachates is shown in the order of detected concentration. It is apparent from this list that leachates are highly mineralized with common salts and can also contain trace quantities of many metals and other contaminants of environmental significance. Leachates from municipal refuse can also contain large quantities of organic materials because of the large quantities of organic material in refuse.

Table 3-8 Sobotka Report: Organic Data from 44 Case Studies
(all concentrations in parts per billion)

CONSTITUENT	PIGEON POINT DE	CENTRAL DE	LITCHFIELD CT	SHELTON CT	EASTERN ALAMEDA CA
Acetone					
Benzene	26				-2
Chloroform			100		-2
1,2 Dichloroethane			-5		-5
Dichloroethane	5		3200		-2
Methyl ethyl ketone					
Methyl isobutyl ketone					
Phenol		1400			-15
Tetrahydrofuran					
Toluene	12.75				-2
Ethyl benzene	42.25				-5
m-Xylene					
1,4 Dichlorobenzene					-2
Trichlorofluoroethane					
1,1 Dichloroethane			140		-2
trans 1,2 Dichloroethane					4
1,1,1 Trichloroethane			80		-5
1,2 Dichloropropane					-5
Chlorobenzene	237				-2
cis 1,2 Dichloroethene					
Chloroethane					-10
Chloroethane					-5
Dichlorodifluoroethane					
1,1,2 Trichloroethane					-7
1,1,2,2 Tetrachloroethane					-7
4 Chlorophenol					-40
Pentachlorophenol					-2
Vinyl chloride					-5
bis (2-Ethylhexyl) phthalate					-5
Diethyl phthalate					-2
Di-n-butyl phthalate					-4
Diethyl phthalate					-4
Naphthalene					4
Tetrachloroethene	80				-2
Trichloroethene	1		-2		
Bromoethane					-10
Carbon tetrachloride					-2
bis (2-Chloroethoxy) methane					-2
Isophorone					-10
Nitrobenzene					-2
Dibromoethane					
2 Propanol					
Ethyl acetate					
1 Butanol					
p-Xylene + o-Xylene					
Endrin					
Toxaphene					
Delta BHC					

Source: Sobotka Report

Negative values indicate detection limits for compounds not detected
Blanks indicate no analysis was performed

Table 3-8 continued

CONSTITUENT	WEST PALM BEACH FLA	SOUTH DADE FLA	PERDIDO FLA	UNKNOWN SITE FLA	RPS INC. CO
Acetone				4.3	
Benzene					
Chloroform				-0.03	
1,2 Dichloroethane					
Dichloromethane					
Methyl ethyl ketone					
Methyl isobutyl ketone		724.5		29.5	
Phenol					
Tetrahydrofuran					
Toluene					
Ethyl benzene					
m-Xylene					
1,4 Dichlorobenzene					
Trichlorofluoromethane					
1,1 Dichloroethane					
trans 1,2 Dichloroethene				0.07	
1,1,1 Trichloroethane					
1,2 Dichloropropane					
Chlorobenzene					
cis 1,2 Dichloroethene					
Chloromethane					
Chloroethane					
Dichlorodifluoromethane					
1,1,2 Trichloroethane					
1,1,2,2 Tetrachloroethane					
4 Nitrophenol					
Pentachlorophenol				-0.13	
Vinyl chloride					
bis (2-Ethylhexyl) phthalate					
Diethyl phthalate					
Di-n-butyl phthalate					
Diethyl phthalate					
Naphthalene				94.52	
Tetrachloroethene					
Trichloroethene					
Bromomethane				397.5	
Carbon tetrachloride					
bis (2-Chloroethoxy) methane					
Isophorone					
Nitrobenzene					
Dibromomethane					
2 Propanol					
Ethyl acetate					
1 Butanol					
p-Xylene + o-Xylene					
Endrin					
Toxaphene					
Delta BHC					

Negative values indicate detection limits for compounds not detected

Table 3-8 continued

CONSTITUENT	COFFIN BUTTE CO	KILLING- WORTH OR	RIVER- BEND OR	ROSEBURG OR	SHORT MOUNTAIN OR
Acetone					
Benzene					
Chloroform					
1,2 Dichloroethane					
Dichloromethane					
Methyl ethyl ketone					
Methyl isobutyl ketone					
Phenol					
Tetrahydrofuran					
Toluene					
Ethyl benzene					
m-Xylene					
1,4 Dichlorobenzene					
Trichlorofluoromethane					
1,1 Dichloroethane					
trans 1,2 Dichloroethene					
1,1,1 Trichloroethane					
1,2 Dichloropropane					
Chlorobenzene					
cis 1,2 Dichloroethene					
Chloroethane					
Chloroethane					
Dichlorodifluoroethane					
1,1,2 Trichloroethane					
1,1,2,2 Tetrachloroethane					
4 Nitrophenol					
Pentachlorophenol					
Vinyl chloride					
bis (2-Ethylhexyl) phthalate					
Diethyl phthalate					
Di-n-butyl phthalate					
Diethyl phthalate					
Naphthalene					
Tetrachloroethene					
Trichloroethene					
Bromoethane					
Carbon tetrachloride					
bis (2-Chloroethoxy) methane					
Isophorone					
Nitrobenzene					
Dibromoethane					
2 Propanol					
Ethyl acetate					
1 Butanol					
p-Xylene + o-Xylene					
Endrin					
Toxaphene					
Delta BHC					

Negative values indicate detection limits for compounds not detected

Table 3-8 continued

CONSTITUENT	TILLAMOOK WA	NEW JERSEY SITES		
		NJ0051128 OCEAN COUNTY LANDFILL NJ	NJ0051449 HAMM S LANDFILL NJ	NJ0007309 LANDFILL & DEVELOPMENT NJ
Acetone	-	-	-	-
Benzene	-	-	8	-
Chloroform	-	-	-	-
1,2 Dichloroethane	-	-	-	-
Dichloromethane	-	1020	60	-
Methyl ethyl ketone	-	-	-	-
Methyl isobutyl ketone	-	-	-	-
Phenol	-	29800	20	2200
Tetrahydrofuran	-	-	-	-
Toluene	-	320	10	-
Ethyl benzene	-	-	10	-
m-Xylene	-	-	-	-
1,4 Dichlorobenzene	-	-	-	-
Trichlorofluoromethane	-	-	-	-
1,1 Dichloroethane	-	-	-	-
trans 1,2 Dichloroethene	-	270	-	-
1,1,1 Trichloroethane	-	200	1	-
1,2 Dichloropropane	-	-	-	-
Chlorobenzene	-	-	-	-
cis 1,2 Dichloroethene	-	-	-	-
Chloroethane	-	-	-	-
Chloroethane	-	-	-	-
Dichlorodifluoroethane	-	269	-	-
1,1,2 Trichloroethane	-	-	-	-
1,1,2,2 Tetrachloroethane	-	-	-	-
4 Nitrophenol	-	-	-	-
Pentachlorophenol	-	-	-	-
Vinyl chloride	-	-	-	-
bis (2-Ethylhexyl) phthalate	-	-	-	-
Diethyl phthalate	-	-	-	-
Di-n-butyl phthalate	-	-	-	-
Diethyl phthalate	-	-	-	-
Naphthalene	-	-	-	-
Tetrachloroethene	-	-	-	-
Trichloroethene	-	5	-	-
Bromoethane	-	-	-	-
Carbon tetrachloride	-	-	6	-
bis (2-Chloroethoxy) methane	-	-	-	-
Isophorone	-	-	-	-
Nitrobenzene	-	-	-	-
Dibromomethane	-	-	-	-
2 Propanol	-	-	-	-
Ethyl acetate	-	-	-	-
1 Butanol	-	-	-	-
p-Xylene + o-Xylene	-	-	-	-
Endrin	0.04	-	-	-
Toxaphene	1	-	-	-
Delta BHC	-	-	-	-

Negative values indicate detection limits for compounds not detected

Table 3-8 continued

CONSTITUENT	WISCONSIN SITES					2
	307 POLK WI	611 WINNEBAGO WI	692 TORK WI	719 DELAFIELD WI	1769 PHEASANT RUN WI	
Acetone						
Benzene						
Chloroform		14.0				
1,2 Dichloroethane						
Dichloroethane		100				
Methyl ethyl ketone						
Methyl isobutyl ketone						
Phenol						
Tetrahydrofuran						
Toluene						
Ethyl benzene						
o-Xylene						
1,4 Dichlorobenzene						
Trichlorofluoroethane						
1,1 Dichloroethane						
trans 1,2 Dichloroethene						
1,1,1 Trichloroethane						
1,2 Dichloropropane						
Chlorobenzene						
cis 1,2 Dichloroethene						
Chloroethane						
Chloroethane						
Dichlorodifluoroethane						
1,1,2 Trichloroethane						
1,1,2,2 Tetrachloroethane						
4 Nitrophenol						
Pentachlorophenol						
Vinyl chloride						
bis (2-Ethylhexyl) phthalate						
Diethyl phthalate						
Di-n-butyl phthalate						
Diethyl phthalate						
Naphthalene						
Tetrachloroethene						
Trichloroethene						
Propoethane						
Carbon tetrachloride						
bis (2-Chloroethoxy) ethane						
Isophorone						
Nitrobenzene						
Dibromomethane						
2 Propanol						
Ethyl acetate						
1 Butanol						
p-Xylene + o-Xylene						
Endrin						
Toxaphene						
Delta BHC						

Negative values indicate detection limits for compounds not detected

Table 3-8 continued

WISCONSIN SITES

CONSTITUENT	2680 DANE WI	2921 SEVEN MILE CREEK WI	2922 JANESVILLE WI	2892 MARATHON WI	2899 MUSKEGO WI
Acetone					
Benzene					
Chloroform			-100		810
1,2 Dichloroethane			1300		-10
Dichloromethane			11300		-10
Methyl ethyl ketone			2500		1000
Methyl isobutyl ketone					
Phenol					
Tetrahydrofuran			-10		200
Toluene			200		200
Ethyl benzene			100		-10
m-Xylene					
1,4 Dichlorobenzene			-20		20
Trichlorofluoroethane			-100		-10
1,1 Dichloroethane			570		20
trans 1,2 Dichloroethene					-10
1,1,1 Trichloroethane			-100		-10
1,2 Dichloropropane			-100		-10
Chlorobenzene			-100		-10
cis 1,2 Dichloroethene			-100		-10
Chloroethane			-100		-10
Chlorobenzene			-100		-10
Dichlorodifluoroethane			-100		-10
1,1,2 Trichloroethane			500		-10
1,1,2,2 Tetrachloroethane			210		-10
4 Nitrophenol			17		-10
Pentachlorophenol			-10		-10
Vinyl chloride			-100		-10
bis (2-Ethylhexyl) phthalate			110		-10
Diethyl phthalate			-20		40
Di-n-butyl phthalate			-10		-10
Diethyl phthalate			-20		-10
Naphthalene			-10		-10
Tetrachloroethene			-100		0
Trichloroethene			-100		-10
Bromoethane			-100		-10
Carbon tetrachloride			-100		-10
bis (2-Chloroethoxy) methane			-10		-10
Isophorone			-10		10
Nitrobenzene			-20		80
Dibromoethane					-10
2 Propanol					
Ethyl acetate					
1 Butanol					
p-Xylene + o-Xylene					
Endrin					
Toxaphene			-1		-0.2
Delta BHC			-1		-0
			4.6		-0.05

Negative values indicate detection limits for compounds not detected

Table 3-8 continued

CONSTITUENT	WISCONSIN SITES		MINNESOTA SITES			
	572 LR WI	2758 FOND DU LAC WI	BETHEL MN	KOOCHICHIWING MN	ROCHESTER MN	
Acetone				7500	11000	
Benzene						
Chloroform	71			-4		
1,2 Dichloroethane	13			-4		
Dichloroethane	3700			250		
Methyl ethyl ketone				8700	2800	
Methyl isobutyl ketone				370	200	
Phenol	221					
Tetrahydrofuran				250	-4	
Toluene	1000			92	910	
Ethyl benzene	230			78	920	
o-Xylene				21	100	
1,4 Dichlorobenzene	-10			-7.7		
Trichlorofluoroethane	18			-4		
1,1 Dichloroethane	5700			17		
trans 1,2 Dichloroethene	1700			-4		
1,1,1 Trichloroethane	2400			-4		
1,2 Dichloropropane	54			-10		
Chlorobenzene	-10			-10		
cis 1,2 Dichloroethene				-4		
Chloroethane	170					
Chloroethane	170					
Dichlorodifluoroethane	180					
1,1,1 Trichloroethane	-10			-4		
1,1,1,2 Tetrachloroethane	-10			-40		
4 Nitrophenol	-25					
Pentachlorophenol	-25					
Vinyl chloride	61					
bis (2-Ethylhexyl) phthalate	74					
Diethyl phthalate	47					
Bis-n-butyl phthalate	12					
Diethyl phthalate	35					
Naphthalene	19					
Tetrachloroethene	26			-40		
Trichloroethene				1.2		
Bromoethane	170					
Carbon tetrachloride	-10			-4		
Bis (2-Chloroethoxy) ethane	-10					
Isophorone	-10					
Nitrobenzene	40					
Dibromoethane				-10		
2 Propanol				10000	8000	
Ethyl acetate				42	-20	
1 Butanol				320	100	
p-Xylene + o-Xylene				18	50	
Endrin	-0.05					
Toxaphene	-0.1					
Delta BHC	-0.01					

Negative values indicate detection limits for compounds not detected

Table 3-8 continued

MINNESOTA SITES

CONSTITUENT	PINE BEND MN	MECKER MN	LYON MN	DULUTH MN	AM MOIS MN
Acetone				140	
Benzene			-2		
Chloroform		-10			
1,2 Dichloroethane		-10			
Dichloromethane		64	200		
Methyl ethyl ketone				110	
Methyl isobutyl ketone				10	
Phenol				19	
Tetrahydrofuran				7.5	
Toluene					
Ethyl benzene				12	
m-Xylene				25	
1,4 Dichlorobenzene		-10	15		
Trichlorofluoromethane		35	45		
1,1 Dichloroethane		17	3.9		
trans 1,2 Dichloroethane		-10	7.6		
1,1,1 Trichloroethane		13	2		
1,2 Dichloropropane		60	-5		
Chlorobenzene		190			
cis 1,2 Dichloroethane					
Chloroethane		-5			
Chloroethane					
Dichlorodifluoroethane		-10	-2		
1,1,2 Trichloroethane		-100	-20		
1,1,2,2 Tetrachloroethane					
4 Nitrophenol					
Pentachlorophenol					
Vinyl chloride					
bis (2-Ethylhexyl) phthalate					
Diethyl phthalate					
Di-n-butyl phthalate					
Diethyl phthalate					
Naphthalene		-100	-20		
Tetrachloroethene		42	42		
Trichloroethene					
Bromoethane		-25	-5		
Carbon tetrachloride					
bis (2-Chloroethoxy) methane					
Isophorone					
Nitrobenzene					
Dibromoethane		-25	5		
2 Propanol				94	
Ethyl acetate				-5	
1 Butanol				-50	
p-Xylene + o-Xylene				12	
Endrin					
Toxaphene					
Delta BHC					

Negative values indicate detection limits for compounds not detected

Table 3-8 Continued

WISCONSIN SITES

CONSTITUENT	WISCONSIN SITES				
	2484 OUTAGAMIE WI	2568 GREEN BAY WEST (DECASTER) WI	2569 GREEN BAY EAST (DECLEENE) WI	2375 RIDGVIEW WI	2627 SUPERIOR WI
pH	7.18	6.4	6.43	6.3	7.1
Total solids			5840		9200
Total suspended solids	268		136	650	
Total dissolved solids	7676	4178	9300		
Total alkalinity	6380	1504	2770		4790
Biological oxygen demand	1645	3048	8236	12000	
Chemical oxygen demand	2118*	3345	8530		5320
Total organic carbon	486				
Total kjeldahl nitrogen	309				275
Total nitrogen					
Ammonia	336		228		209
Nitrite					-0.2
Nitrate	-0.1		0		-0.2
Organic nitrogen					
Sulfate	255				
Fluoride					
Chloride	1400	940	1040		
Cyanide				-4	
Aluminum			-1		
Arsenic	-0.01				-0.01
Barium	-2				
Cadmium	-0.03		-0.05	0.06	0.209
Total Chromium	1		-0.1	0.4	0.06
Copper	0.1		-0.1	0.1	0.12
Iron	15.85	4	29.5	385	
Lead	0.3		-0.5	-0.5	0.25
Magnesium	200		210.5		
Manganese	1.4		2.87		
Mercury	-0.001				0.0003
Nickel	0.18		-0.1	1.25	0.1
Selenium	-0.05				
Sodium		321	508		
Zinc	2		0.42	10	3.13
Total phosphate	1.08		1.31	4.6	
Hardness	2240	1825	3670		
Calcium	321		425		
Potassium	560		46.5	31	
Antimony					
Beryllium					
Silver	-0.03				
Thallium					
Conductivity	15485	4390	7635		6800
Nitrate + Nitrite					
Boron					
Cobalt					
Hexavalent chromium				-0.05	

Negative values indicate detection limits for compounds not detected

Table 3-9 Concentration of Selected Organic Compounds Identified in Municipal Landfill Leachate or Groundwater Plume.

Chemical	Concentration Range (mg L ⁻¹) ¹ Municipal Landfill
Acetic Acid	DT
Acetone	3.4-1300
C5-Acid	140
C6-Acid	82
Acrolein	170
Aldrin	-
Aniline	.01-.870
Benzene	.004-1300
Benzendicarboxylic acid	.06
Benzene hexachloride	4.6
Biphenyl naphthalene	-
Bis(chloromethyl) ether	12.4-250
Bis(2 ethylhexyl)phthalate	34-150
Bis-2-hydroxypropyl ether	DT
Bromodichloromethane	-
Bromoethane	170
Bromoform	.0002
2-Butanol	.120-46
Butoxyethanol	DT
Butylbenzyl phthalate	DT
Butylcarbobotoxymethyl phthalate	DT
Butyric acid	1.5
Camphor	0.9
Caproic acid	.0011
Caprylic acid	.0006
Carbon tetrachloride	-
o-chloroaniline	.140
Chlorobenzene	.0046-60
Chlorodibromoethane	-
Chloroform	.0011-1300
Chloromethane	170

Table 3-9 continued

Concentration Range (mg L⁻¹)¹
Municipal Landfill

Chemical

4-chloro-3-nitrobenzamide	4.2
Chloronitrobenzene	.720
Chloronitrotoluene	.120
2-chlorophenol	.003
Cis-1,2-dichloroethylene	.19
p-Cresol	.014-15
Cyanide	-
Cyclohexane carboxylic acid	.0028
Cyclohexanol	.001
Diacetone alcohol	.011
Dibromochloromethane	.0039
Dibutylphthalate	12-150
2,6-dichlorobenzamine	.89-30
Dichlorobenzene	.014-16
Dichloroethane	.0021-1,100
1,2-Dichloroethane	.015
1,2-dichloroethene	190-.470
1,1-dichloroethylene	DT
Dichloromethane	.015-20,000
2,4-dichlorophenol	-
Dichloropropane	.002-54
Dichloropropene	-
Dicyclohexyl phthalate	.0002
1,2-diethylbenzene	-
N,N-diethylformamide	DT
Diethylphthalate	.004-300
Dimethylphenol	30-55
Di-n-butyl phthalate	DT
Diethyl phthalate	.002
Diphenylamine	.190
2,4-dinitrophenol	.099

Table 3-9 continued

Concentration Range (mg L⁻¹)
Municipal Landfill

Chemical

2,6-Di-t-butylbenzonquinone	DT
Ethanol	23-110,000
2-ethoxy-ethanol	-
1-ethoxy-propane	.018-.290
Ethyl acetate	.003-820
Ethyl benzene	DT
Ethyl carbamate	-
1-ethyl-2,4,-dimethylbenzene	-
1-ethyl-3,5-dimethylbenzene	2.6
2-ethyl hexanal	22.0
2-ethyl hexanol	.0042
2-ethyl hexanoic acid	DT
N-ethyl-o-toluene sulfonamide	0.1
N-ethyl-p-toluene sulfonamide	.0012
Fluorene	-
Freon	-
Heptachlor	.001
Heptanoic acid	600-800
Heptanone	-
Hexachlorobutadiene	-
Hexachlorocyclohexane	5-900
Hexane	0.148
2-Hexanone	49
Isobutyric acid	4,000-6000
Isophorone	.0007
Isovaleric acid	160
Methanol	160
Methyl acetone	-
2-methyl-2-butanol	.064-1.3
Methyl chloride	DT
3-methylcyclopentane-1,2-diol	

Table 3-9 continued

Concentration Range (mg L⁻¹)
Municipal Landfill

Chemical

Methyl ethyl ketone	0.47-27,000
Methyl isobutyl ketone	0.176-200
Methyl naphthalene	.033
4-methyl-2-pentanol	-
4-methyl-2-pentanone	DT
Methylpyridine	.110-19
Naphthalene	180
o-nitroaniline	37
p-nitroaniline	.25
Nitrobenzene	11
o-nitrophenol	.042
Palmitic acid	640
Pentane	11.7
Pentanol	-
Pentachlorophenol	.46-5790
Phenol	2.8
Polychlorinated biphenyls	1.9-3400
1-propanol	-
2-propanol	-
Propionic acid	.009
Stearic acid	210
Tetrachloroethane	.017-.24
Tetrachloroethylene	.14-.430
Tetrahydrofuran	.019
Tetramethyl thiourea	.059-1,600
Toluene	DT
p-Toluenesulfonamide	-
Toxaphene	.004-.088
Trans-1,2-dichloroethylene	-
1,2,4-trichlorobenzene	.0042-.0056
1,1,1-Trichloroethane	.39-.87
1,1,2-Trichloroethane	

Table 3-9 continued

Chemical	Concentration Range (mg L ⁻¹) ¹ Municipal Landfill
Trichloroethane	.005-35
Trichloroethene	.125
Trichloroethylene	2.1
Trichlorofluoroethane	-
Trichlorofluoromethane	15
Trichloromethane	-
Tributyl phosphate	.0012
Triethyl phosphate	.0003-.015
Tri-n-butyl phosphate	1.7
Trimethylbenzene	.22
Valeric acid	.0011
Vinyl chloride	0.02-61
Xylene	.029-170

Concentration range: DT=detected but concentration not determined.

Source: Texas A & M University Report

TABLE 3-10

CONTAMINANT CONCENTRATION FROM LEACHATE OF THREE MUNICIPAL LANDFILLS
 [Concentrations in mg/l (ppm)]

Parameter	Lyon Municipal Landfill	Meeker Municipal Landfill	Rochester Municipal Landfill
Benzene(a)	0.036	0.270	0.54
Butanol(a)	25	0.120	10.
Chlorobenzene		0.060	
Cis-1,2-Dichloroethylene		0.190	0.47
1,1-Dichloroethane(a)	0.046	0.035	0.026
1,2-Dichloroethane			0.006
1,2-Dichlorobenzene(a)	0.019	0.032	0.010
1,4-Dichlorobenzene(a)			0.014
Dichloromethane(a)	0.200	0.064	1.3
1,2-Dichloropropane	0.002	0.013	0.081
Ethanol(a)	110.		23.
Ethyl Acetate	0.290	0.018	0.130
Ethyl Benzene	0.015	0.820	0.250
Methyl Ethyl Ketone	0.650	9.8	27.
Methyl Isobutyl Ketone	0.087	0.410	0.710
1-Propanol(a)	37.	0.076	11.
2-Propanol(a)	41.	1.9	26.
Tetrachloroethylene(a)			0.250
Tetrahydrofuran	0.280	0.140	0.430
Toluene(a)	0.180	0.390	0.6
Trans-1,2-Dichloroethylene(a)	0.0038	0.017	0.088
Trichloroethane(a)	0.0076		
Trichloroethylene(a)	0.043	0.043	0.125
Xylene(a)	0.092	0.32	0.198

Source: Texas A&M University Report
 (a) = potential carcinogens

Table 3-11 Overall Summary from the Analysis of Municipal Solid Waste Leachates in Wisconsin

Parameter	Overall Range (1)	Typical Range (range of site medians) (1)	Number of Analyses
TDS	584-50430	2180-25873	172
Specific Conductance	480-72500	2840-15485	1167
Total Susp Solids	2-140900	28-2835	2700
BOD	ND-195000	101-29200	2905
COD	6.6-97900	1120-50450	467
TOC	ND-30500	427-5890	52
pH	5-8.9	5.4-7.2	1900
Total Alkalinity(CaCO3)	ND-15050	960-6845	328
Hardness(CaCO3)	52-225000	1050-9380	404
Chloride	2-11375	180-2651	303
Calcium	200-2500	200-2100	9
Sodium	12-6010	12-1630	192
Total Kjeldahl Nitrogen	2-3320	47-1470	156
Iron	ND-1500	2.1-1400	416
Potassium	ND-2800	ND-1375	19
Magnesium	120-780	120-780	9
Ammonia-Nitrogen	ND-1200	26-557	263
Sulfate	ND-1850	8.4-500	154
Aluminum	ND-85	ND-85	9
Zinc	ND-731	ND-54	158
Manganese	ND-31.1	0.03-25.9	67
Total Phosphorus	ND-234	0.3-117	454
Boron	0.87-13	1.13-12.3	15
Barium	ND-12.5	ND-5	73
Nickel	ND-7.5	ND-1.65	133
Nitrate-Nitrogen	ND-250	ND-1.4	88
Lead	ND-14.2	ND-1.11	142
Chromium	ND-5.6	ND-1.0	138
Antimony	ND-3.19	ND-0.56	76
Copper	ND-4.06	ND-0.32	138
Thallium	ND-0.78	ND-0.31	70
Cyanide	ND-6	ND-0.25	86
Arsenic	ND-70.2	ND-0.225	112
Molybdenum	0.01-1.43	0.034-0.193	7
Flu	ND-0.16	0.16	3
Nitrite-Nitrogen	ND-1.46	ND-0.11	20
Selenium	ND-1.85	ND-0.09	121
Cadmium	ND-0.4	ND-0.07	158
Silver	ND-1.96	ND-0.024	106
Beryllium	ND-0.36	ND-0.008	76
Mercury	ND-0.01	ND-0.001	111

(1): All concentrations in mg/l except pH(std. units) and sp. cond.(umhos/cm)

Source: Wisconsin Department of Natural Resources Report

The wide variation in leachate quality at Wisconsin landfills can, in part, be attributed to strength-controlling factors. Shallower depths of refuse and dilution by surface water, for instance, will result in lower leachate parameter concentrations. Correlations shown between specific conductance and the concentrations of major leachate contaminants indicate that a general model of contamination is possible. Such a model reflects the uniformity of municipal solid waste and the similarities in Wisconsin sites. As these sites age and the contaminants respond differently to the changing landfill environment, these ratios are expected to change.

The similarities in Wisconsin sites and waste composition allow an order of magnitude approximation to the concentrations found in leachate to be made. In Table A-3, these ranges are summarized for many leachate contaminants.

A perspective on the magnitude of the concentrations of contaminants found in Wisconsin leachates can be obtained from the results shown in Table 3-12. This table compares the median and maximum concentrations in Wisconsin leachates to the Primary Drinking Water Standards and enables the leachate concentrations to be described as multipliers of the standards. From Table 3-12, where data are available, it can be seen that the median leachate concentrations exceed the Primary Drinking Water Standards routinely for cadmium, chromium, and lead; less frequently for arsenic, barium, and selenium; and never for nitrates and silver.

The maximum leachate concentrations exceeded all of the Primary Drinking Water Standards in at least one instance. Very high multipliers of the drinking water standards were encountered at some sites, particularly at the larger sites and those with a history of industrial waste codisposal.

Leachate median and maximum concentrations have also been expressed as multipliers of the Secondary Drinking Water Standards in Table 3-12. The secondary standards were commonly exceeded for chloride, iron, manganese, and total dissolved solids (approximated by specific conductance). The secondary drinking water multipliers are highest for iron.

Table 3-12 Comparison of Leachate Concentrations with Drinking Water Standards

Site Number	Primary Drinking Water Standards															
	Arsenic (0.05mg/l)		Barium (1.0 mg/l)		Cadmium (0.01mg/l)		Chromium (0.05mg/l)		Lead (0.05mg/l)		Mercury (0.002mg/l)		Selenium (0.01mg/l)		Silver (0.05mg/l)	
	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS	Median Times (mg/l)	DWS
11	0.009	0	0.84	1	0.006	1	0.03	1	0.069	1	0.0001	0	0.001	0	0.0075	0
307			0.30	0			0.528	11								
572	0.002	0	0.225	0	0.05	5	0.64	13	0.03	1	0.0002	0	0.02	2	0.0008	0
611	ND	0			ND	0	ND	0	ND	0	ND	0				
652	0.002	0			0.015	2	0.059	1	0.1	2	0.0006	0	ND	0	0.009	0
719					ND	0										
1099	0.015	0	1.3	1	0.021	2	0.31	6	0.29	6	0.0003	0	0.001	0	0.013	0
1678	0.225	5	1.3	1	0.039	4	0.34	7	0.46	9	0.0006	0	0.006	1	0.024	0
1739	0.07	1	2.69	3	0.05	5	0.23	5	1.11	22	ND	0	0.09	9	ND	0
2358																
2484	ND	0	ND	0	ND	0	1	20	0.3	6	ND	0	ND	0	ND	0
2568																
2569					ND	0	ND	0	ND	0						
2575					0.06	6	0.4	4	ND	0						
2627	ND	0			0.009	1	0.06	1	0.25	5	0.0003	0				
2680																
2821	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
2822	0.001	0	5.0	5	0.07	7	0.05	1	0.07	1						
2892	ND	0	ND	0	ND	0	0.01	0	0.015	0	ND	0				
2895	0.015	0	0.6	1	0.015	2	0.18	4	0.13	3	0.001	1	0.002	0	0.008	0
Site Number	Max Times (mg/l)		Max Times (mg/l)		Max Times (mg/l)		Max Times (mg/l)		Max Times (mg/l)		Max Times (mg/l)		Max Times (mg/l)		Max Times (mg/l)	
	DWS		DWS		DWS		DWS		DWS		DWS		DWS		DWS	
11	0.015	0	2.1	2	0.015	2	0.06	1	0.2	4	0.0025	1	0.005	1	0.02	0
307			0.44	0			0.568	11								
572	0.03	1	0.75	1	0.4	40	5.6	112	0.44	9	0.002	1	0.032	3	0.01	0
611	ND	0			ND	0	ND	0	ND	0	ND	0				
652	0.014	0			0.060	6	0.180	4	0.140	7	0.0084	4	0.033	3	0.050	1
719					ND	0										
1099	0.059	1	2.12	2	0.100	10	2.560	51	1.200	24	0.0100	5	0.035	4	0.029	1
1678	70.2	1404	11.5	12	0.16	16	1.85	37	1.4	28	0.0076	4	0.054	5	0.083	2
1739	1.29	26	12.5	13	0.17	17	2.01	40	14.2	294	0.0004	0	1.85	185	0.07	1
2358																
2484	ND	0	ND	0	ND	0	1	20	0.3	6	ND	0	ND	0	ND	0
2568																
2569					ND	0	ND	0	ND	0						
2575					0.2	20	0.7	14	1	20						
2627	ND	0			0.009	1	0.06	1	0.25	5	0.0003	0				
2680																
2821	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
2822	0.001	0	5.0	5	0.09	9	0.26	5	0.07	1						
2892	ND	0	ND	0	ND	0	0.02	0	0.03	1	ND	0				
2895	0.04	1	1.25	1	0.3	30	0.53	11	0.43	9	0.0042	2	0.034	3	0.186	4
Avg. for Medians	0.5		1.1		2.1		4.8		3.8		0.1		1.3		0.1	
Avg. for Maximum	110.2		3.2		9.4		19.2		26.5		1.5		22.7		1.0	

*Value exceeds U.S. EPA Maximum Concentration of Contaminants for Characteristic of EP Toxicity

Table 3-12 continued

Secondary Drinking Water Standards

Site Number	Chloride (250 mg/l)		Copper (1.0 mg/l)		Iron (0.3 mg/l)		Manganese (0.05 mg/l)		Sulfate (250 mg/l)		TDS (900 mg/l)		Zinc (5.0 mg/l)	
	Median Time (mg/l)	Time DWS	Median Time (mg/l)	Time DWS	Median Time (mg/l)	Time DWS	Median Time (mg/l)	Time DWS	Median Time (mg/l)	Time DWS	Median Time (mg/l)	Time DWS	Median Time (mg/l)	Time DWS
11			0.02	0	10.3	34					9000	18	0.152	0
307	885	4	0.321	0	350	1197	25.9	518	155	1	9183	16	54.0	11
172	923	4	0.17	0	211	703	0.5	10	0.4	0	10005	20	22	4
611	350	1	ND	0	2.1	7	0.03	1	112	0	3540	7	ND	0
652			0.029	0							1804	12	0.153	0
114	980	4	ND	0	240	920	3.1	62	500	2	10150	20	1.9	0
1096	2631	11	0.049	0	9.12	20	1.45	29	271.5	1	10800	21	1.65	0
1678	2270	9	0.09	0	113	177	2.83	57	200	1	13750	28	28.9	6
1739	759	3	0.3	0	169	563					5000	10	67.7	10
2358	795	3		0	48.45	154			108	0	6375	13		
2484	1400	6	0.1	0	15.93	53	1.4	28	255	1	15485	31	2	0
2568	840	3		0	4	13					4390	9		
2569	1040	4	ND	0	29.5	94	2.47	57			7635	15	0.42	0
2575			0.1	0	385	1283						10	2	
2627			0.12	0							6809	14	3.13	1
2690	1770	7		0	500	1667					15100	30		
2821	700	3	ND	0	1400	4667	22	440	210	1	7800	16	2.4	0
2822	900	1	0.09	0	150	500	1.15	27	300	1	9250	19	0.64	0
2892	180	1	0.05	0	88.2	221			140	1	2840	6	0.03	0
2895			0.058	0			1.795	36					1.98	0

Site Number	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS	Gas (mg/l)	Time DWS
11			0.04	0	10.3	34			9000	18	0.54	0				
307	1275	5	0.399	0	638	2087	30.5	610	1400	6	11080	22	69.4	14		
572	1876	8	0.56	1	1500	5000	9.8	186	200	1	17500	35	42.3	8		
611	1440	6	.80	0	670	2233	0.03	1	911	4	22500	45	40	0		
652			0.122	0					16320	33	13.1	3				
719	2200	9	.80	0	1240	4133	19	380	750	3	72500	145	1.6	0		
1040	11375	46	0.270	0	788	2627	31.1	622	1850	7	32000	64	162	32		
1676	5140	23	0.28	0	1050	3500	26.7	534	1670	7	28000	56	72.5	15		
1739	1600	6	4.08	4	879	2030			1700	0	17200	34	731	146		
2358	1630	7		0	269	897			108	0	10800	22				
2484	1500	6	0.1	0	210.0	700	1.4	28	411	2	19400	39	2	0		
2568	1690	7		0	62.6	209			14000	28						
2569	2520	10	.80	0	322	1073	2.93	59		24500	49	0.62	0			
2575			0.15	0	610	2033						22	4			
2627			0.12	0					6400	14	3.13	1				
2680	2310	8		0	660	2867			19100	38						
2821	1100	4	.98	0	1540	5000	22	440	120	3	11500	23	3.4	1		
2822	540	2	0.16	0	400	1333	1.35	27	300	1	12200	24	0.84	0		
2882	625	3	0.06	0	432	1440			747	3	8700	17	0.05	0		
2895			0.181	0			2.35	47				26.4	5			
Avg. for Medium		4.2		0.1		728.2		119.0		0.6		16.9		2.1		
Avg. for Maximum		10.0		0.4		2241.0		267.6		3.3		29.2		13.5		

Source: Wisconsin Department of Natural Resources Report

Table 3-12 also illustrates how the maximum value for arsenic at Site 1678 (Table 3-1) exceeded the EPA maximum concentration limit of 5.0 mg/l (ppm). This indicates the leachate would be classified as a hazardous waste because of its value of 70.2 mg/l (ppm). The EPA maximum concentration limits are listed below.

Contaminant	Maximum Concentration (mg/l)
Arsenic	5.0
Barium	100.0
Cadmium	1.0
Chromium	5.0
Lead	5.0
Mercury	0.2
Selenium	1.0
Silver	5.0
Endrin	0.02
Lindane	0.4
Methoxychlor	10.0
Toxaphene	0.5
2,4-D	10.0
2,4,5-TP Silvex	1.0

Table 3-12 also illustrates that Site 1739 (Table 3-1) exceeded the EPA maximum concentration limit for lead, which is 5.0 mg/l (ppm). Site 1739 had a maximum value of 14.2 mg/l (ppm). Site 1739 on Table 3-12 also shows a maximum value of 1.85 mg/l (ppm) for selenium. The EPA maximum concentration limit of selenium is 1.0 mg/l (ppm). Either one of these two parameters would classify the leachate as hazardous waste. Site 1678 reports accepting municipal, industrial, and hazardous wastes, whereas Site 1739 reports accepting municipal and industrial wastes.

Appendix B, Table B-1 summarizes each Wisconsin site regarding parameters and site characteristics that were discussed in the Wisconsin report.

Tables 3-13 and 3-14 are Sobotka tables that provide a summary of municipal leachate concentrations. They list minimum, maximum, and median values for

Table 3-13 Sobotka Report: Data Summary of Organic

MSW Leachate Concentrations

(All values in ppm)

CONSTITUENT	MIN	MAX	MEDIAN
Acetone	0.140	11.000	7.500
Benzene	0.002	0.410	0.017
Chloroform	0.002	1.300	0.010
1,2-Dichloroethane	0.000	11.000	0.0075
Dichloromethane	0.002	3.300	0.230
Methyl ethyl ketone	0.110	28.000	8.300
Methyl isobutyl ketone	0.010	0.660	0.270
Phenol	0.010	28.800	0.257
Tetrahydrofuran	0.005	0.260	0.018
Toluene	0.002	1.600	0.166
Ethyl Benzene	0.005	0.580	0.038
m-Xylene	0.021	0.079	0.026
1,4-Dichlorobenzene	0.002	0.020	0.0077
Trichlorofluoromethane	0.004	0.100	0.0125
1,1-Dichloroethane	0.002	6.300	0.0655
trans-1,2-Dichloroethene	0.004	1.300	0.010
1,1,1-Trichloroethane	0.000	2.400	0.010
1,2-Dichloropropane	0.002	0.100	0.010
Chlorobenzene	0.002	0.237	0.010
cis-1,2-Dichloroethane	0.004	0.190	0.097
Chloromethane	0.010	0.170	0.055
Chloroethane	0.005	0.170	0.0075
Dichlorodifluoromethane	0.010	0.369	0.095
1,1,2-Trichloroethane	0.002	0.500	0.010
1,1,2,2-Tetrachloroethane	0.007	0.210	0.020
4 Nitrophenol	0.017	0.040	0.025
Pentachlorophenol	0.003	0.025	0.003
Vinyl chloride	0.000	0.100	0.010
bis (2-Ethylhexyl) phthalate	0.006	0.110	0.022
Diethyl phthalate	0.002	0.055	0.0315
Di-n-butyl phthalate	0.004	0.012	0.010
Dimethyl phthalate	0.004	0.055	0.015
Naphthalene	0.004	0.019	0.008
Tetrachloroethene	0.002	0.100	0.040
Trichloroethene	0.001	0.043	0.0035
Bromomethane	0.010	0.170	0.055
Carbon tetrachloride	0.002	0.398	0.010
bis(2-Chloroethoxy) methane	0.002	0.014	0.010
Isophorone	0.010	0.085	0.010
Nitrobenzene	0.002	0.040	0.015
Dibromomethane	0.005	0.025	0.010
2-Propanol	0.094	10.000	6.900
Ethyl acetate	0.005	0.050	0.042
1-Butanol	0.050	0.360	0.220
p-Xylene + o-xylene	0.012	0.050	0.018
Endrin	0.000	0.001	0.0001
Toxaphene	0.000	0.005	0.001
Delta BHC	0.000	0.005	0.008

Source: Sobotka Report

Table 3-14 Sobotka Report: Data Summary on Inorganic MSW Leachate Concentrations
(All values in ppm)

CONSTITUENT	MIN	MAX	MEDIAN
pH	5.4	8.0	6.690
TS	1900.0	25873.0	10040.0
TSS	28.0	2835.0	301.0
TDS	1400.0	16120.0	6453.3
Tot alkalinity	0.0	7375.0	2430.0
BOD	7.0	21600.0	2330.0
COD	440.0	50450.0	3387.5
TOC	5.0	6884.0	558.0
TKN	47.3	938.0	309.0
NH ₄	11.3	1200.0	200.0
NO ₂	0.007	0.20	0.020
NO ₃	0.000	50.950	0.340
Organic N	4.5	78.2	62.5
Sulfate	8.0	500.0	108.0
Fluoride	0.120	0.790	0.400
Chloride	120.0	5475.0	695.0
Cyanide	0.000	4.000	0.020
Al	0.010	5.070	0.655
As	0.000	0.080	0.010
Ba	0.010	10.000	0.383
Cd	0.000	0.100	0.015
Cr (total)	0.001	1.000	0.060
Cu	0.003	0.320	0.070
Fe	0.22	1400.00	66.20
Pb	0.001	1.110	0.080
Mg	76.0	927.0	143.0
Mn	0.030	43.00	1.60
Hg	0.000	0.020	0.0006
Ni	0.010	1.250	0.160
N	12.0	1200.0	539.0
Zn	0.010	67.000	1.350
Tot Phosphate	0.00	117.18	1.72
Hardness	0.8	9380.0	1845.0
Ca	95.5	2100.0	336.0
K	30.0	1375.0	48.0
Sb	0.002	1.100	0.470
Be	0.001	0.010	0.0065
Ag	0.008	0.050	0.020

Source: Sobotka Report

inorganic and organic constituents respectively. This information is also presented in Table 3-2, which provides a comparison of literature values to the concentration values presented in the Wisconsin and Sobotka studies.

Comparing the endrin and toxaphene values in Table 3-13 to the maximum EPA concentration values for EP toxicity (Subtitle D), neither substance exceeded the limit. Endrin must not exceed 0.02 mg/l (ppm) and toxaphene must not exceed 0.5 mg/l (ppm). In both of these comparisons, the leachate should be considered hazardous for these specific parameters, since the EPA's EP toxicity limits dictate whether a substance would be classified as a hazardous waste.

Comparing the arsenic, barium, cadmium, chromium, lead, mercury, and silver values in Table 3-14 to maximum EPA concentration values for EP toxicity, indicates that the limits were not exceeded.

In the Wisconsin report data, endrin and toxaphene were not detected (limit <10 ppb) in one Wisconsin leachate sample.

Also listed in the EP toxicity maximum concentrations are 2,4-D, (2,4-Dichlorophenoxy-acetic acid) and 2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid). Detected in two leachate analysis (limit F10 ppb) was 2,4-D. See Table A-2 for values.

REFERENCES

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APPENDIX A
RANGE GRAPHS AND MEDIAN
FREQUENCY-OF-OCCURRENCE HISTOGRAMS

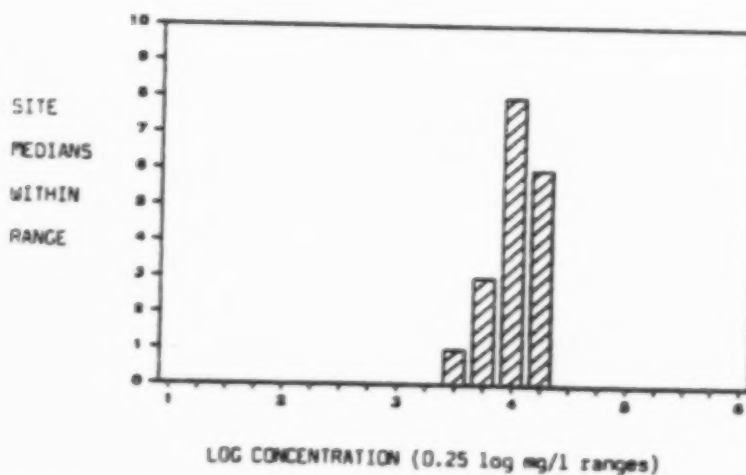
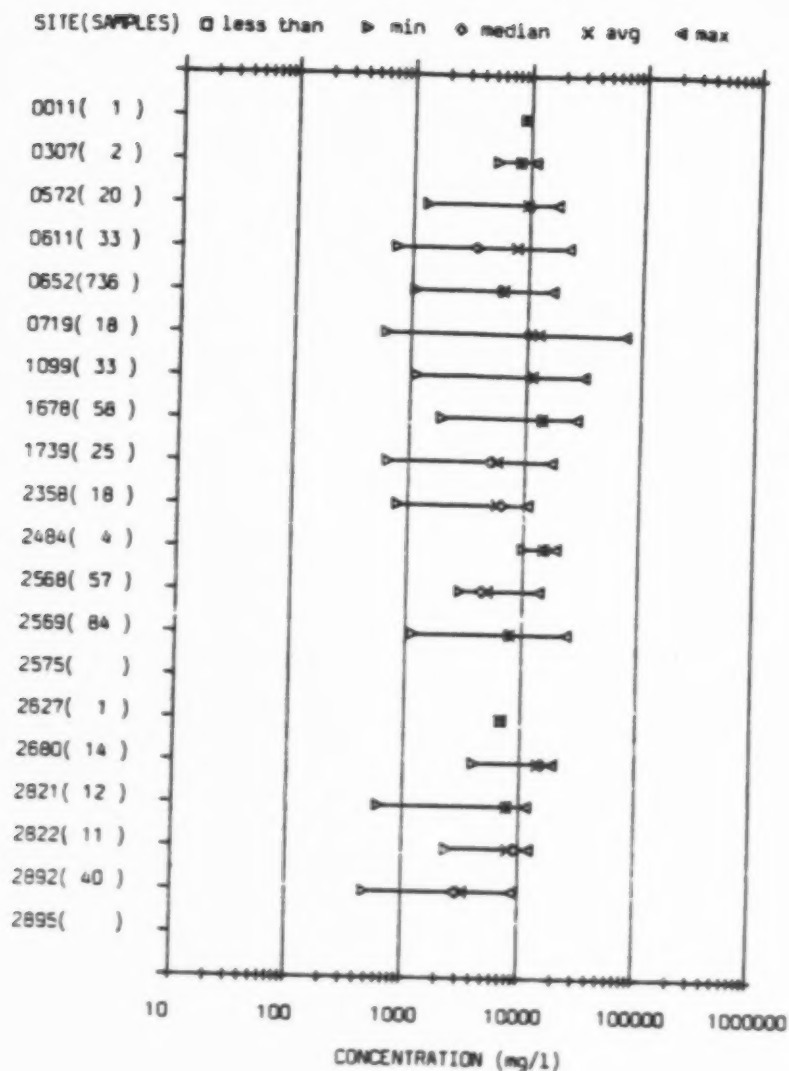


Figure A-1 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Specific Conductance.

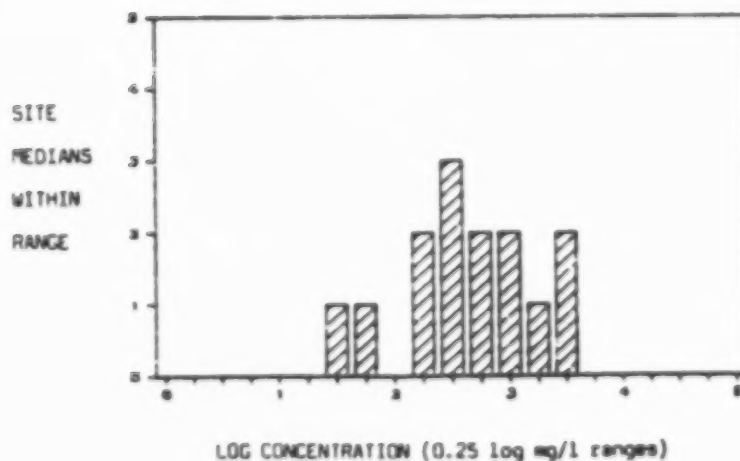
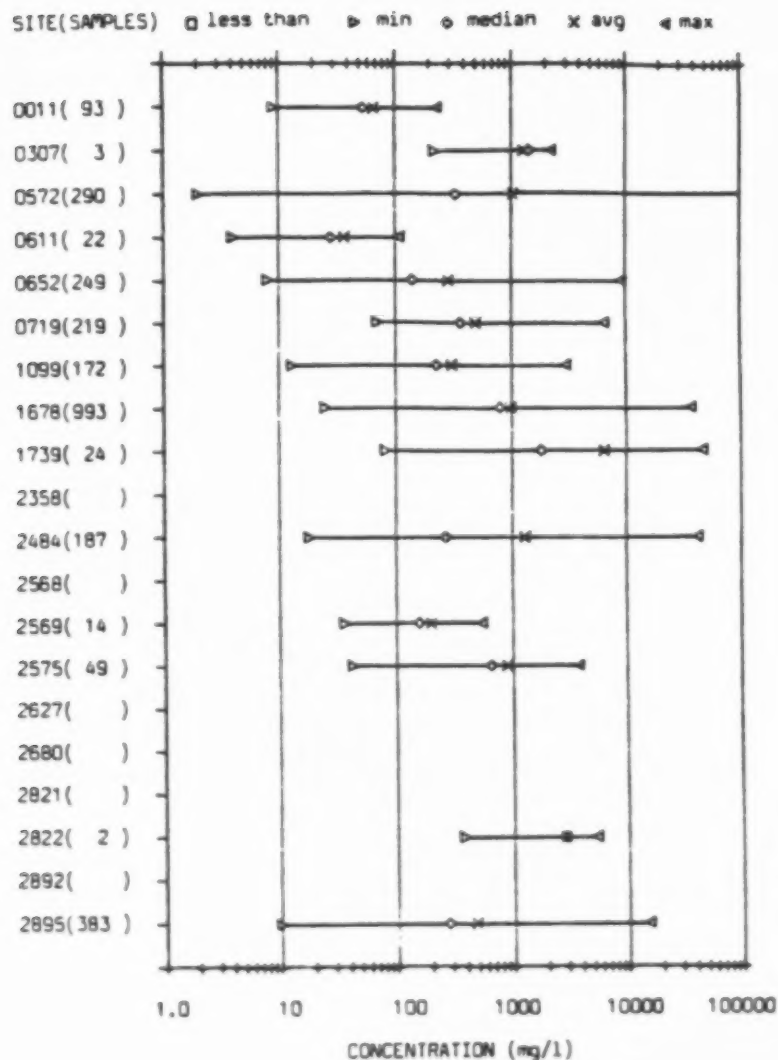


Figure A-2 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Total Suspended Solids Concentrations.

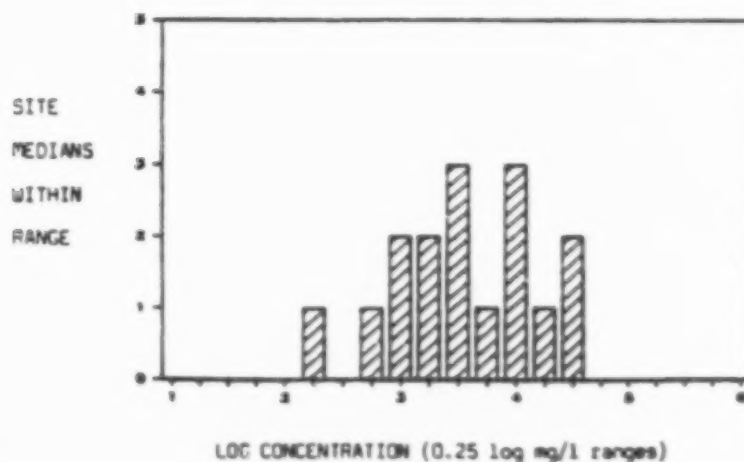
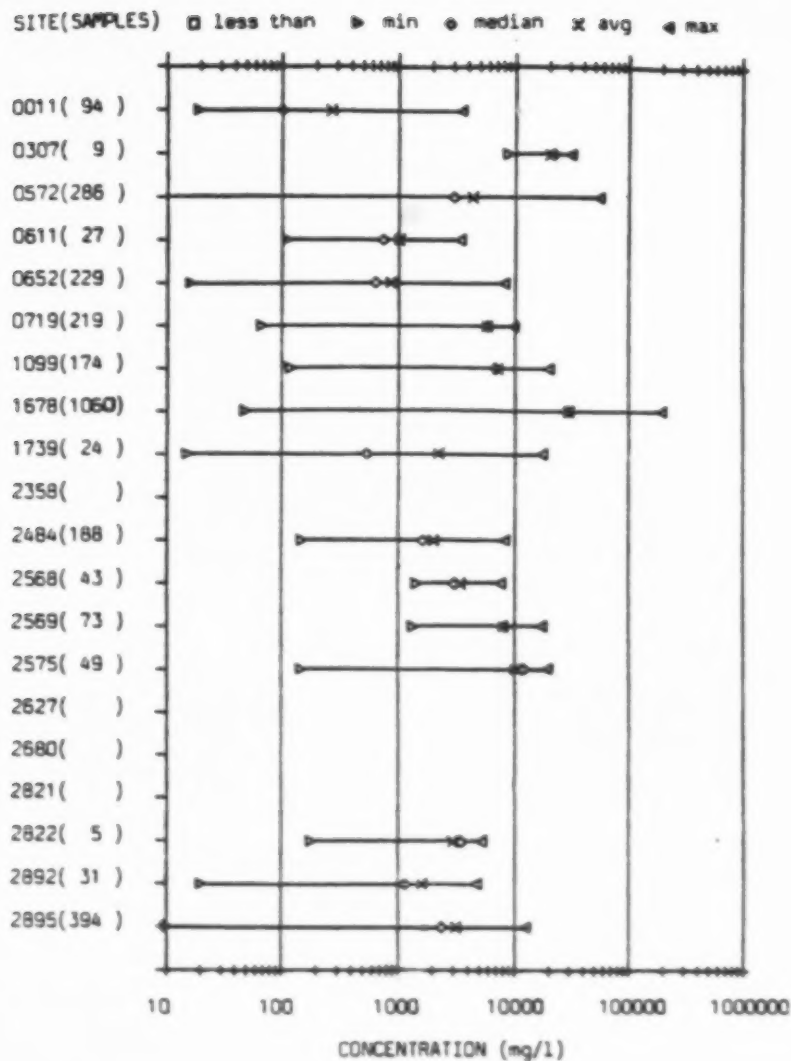


Figure A-3 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Biochemical Oxygen Demand(BOD).

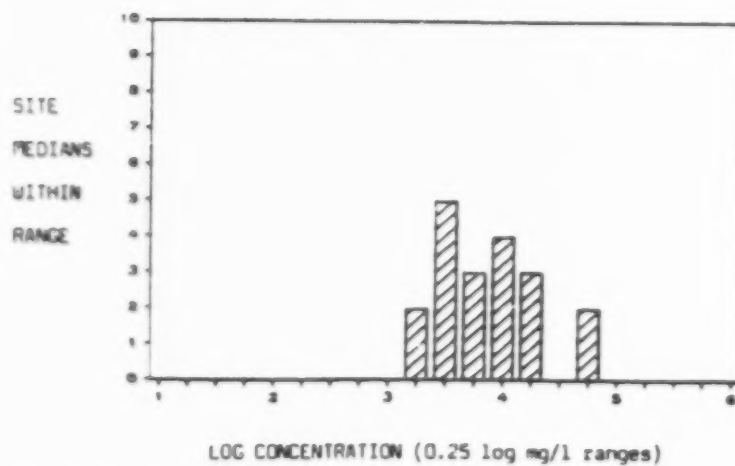
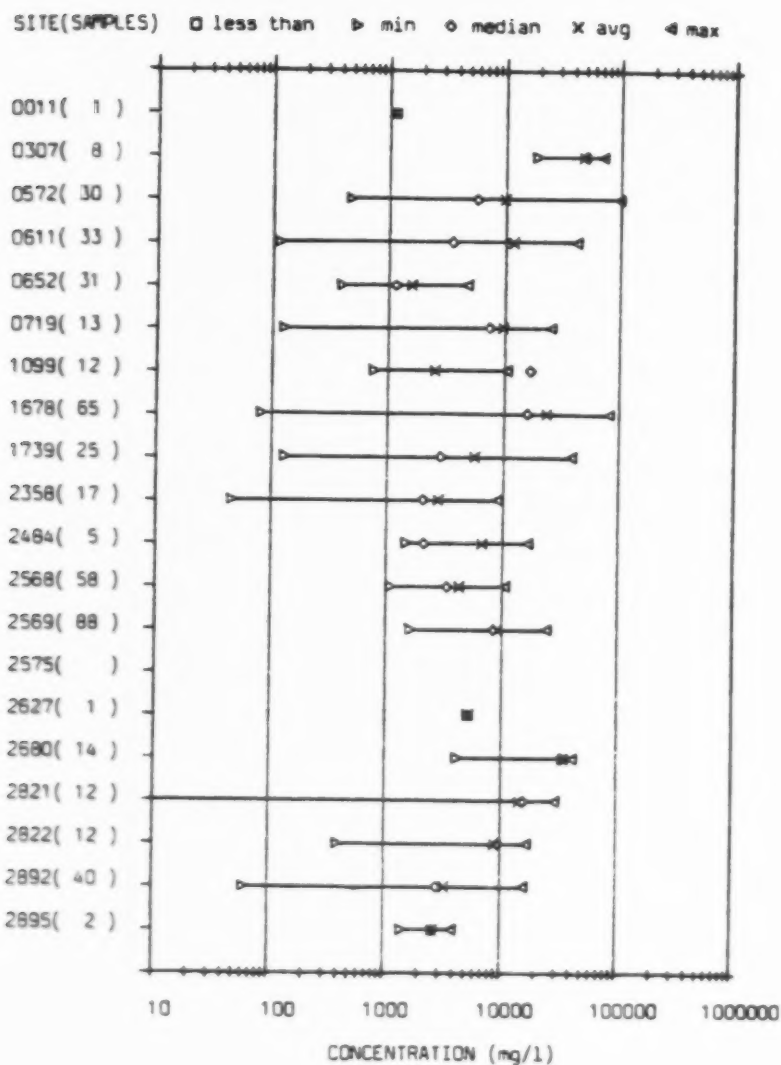


Figure A-4 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Chemical Oxygen Demand(COD).

SITE(SAMPLES) □ less than ▷ min ○ median × avg ◁ max

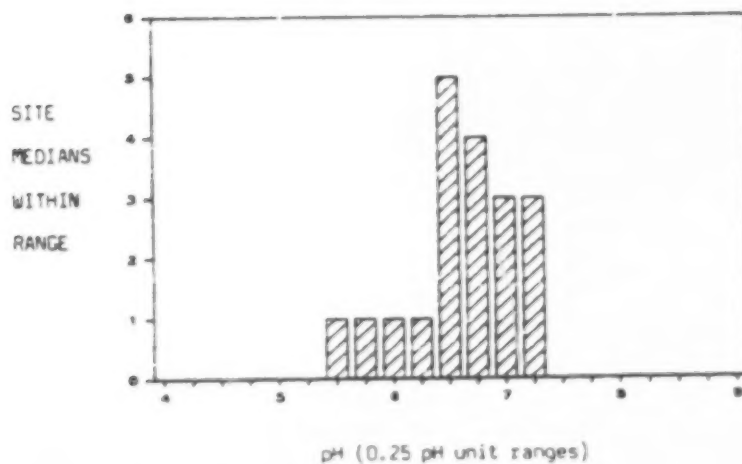
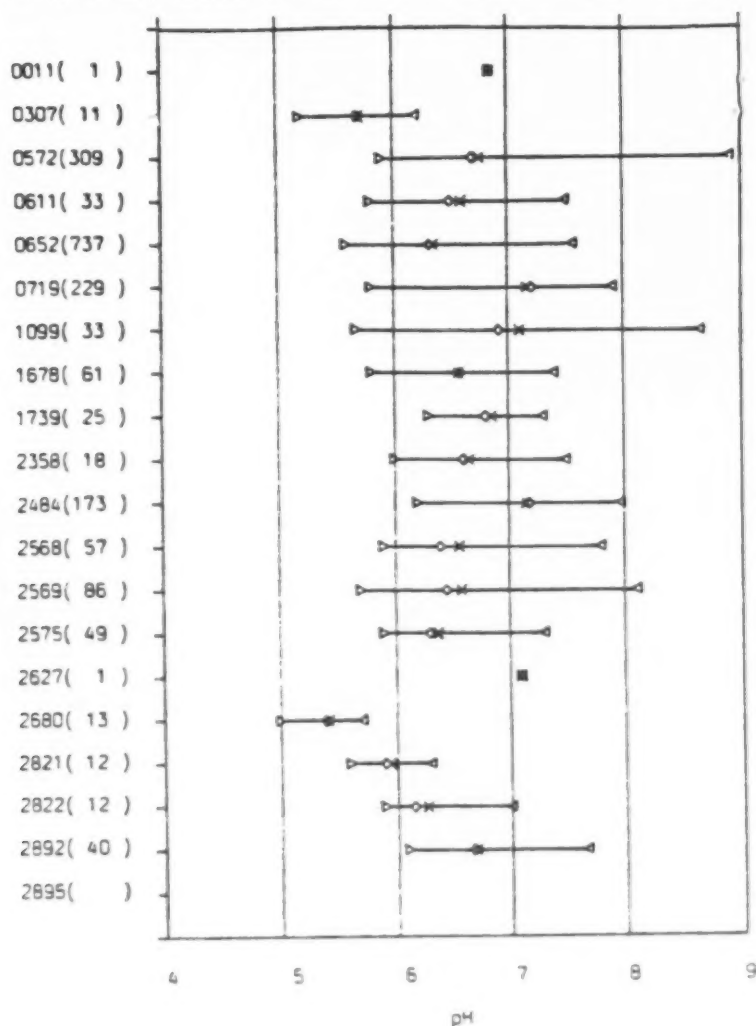


Figure A-5 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate pH.

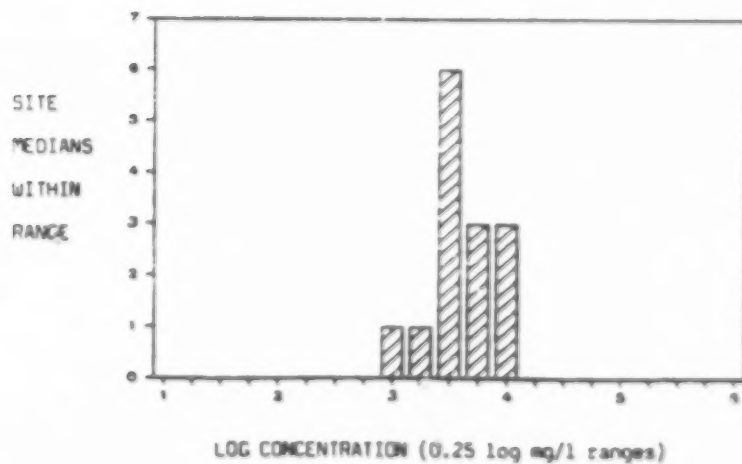
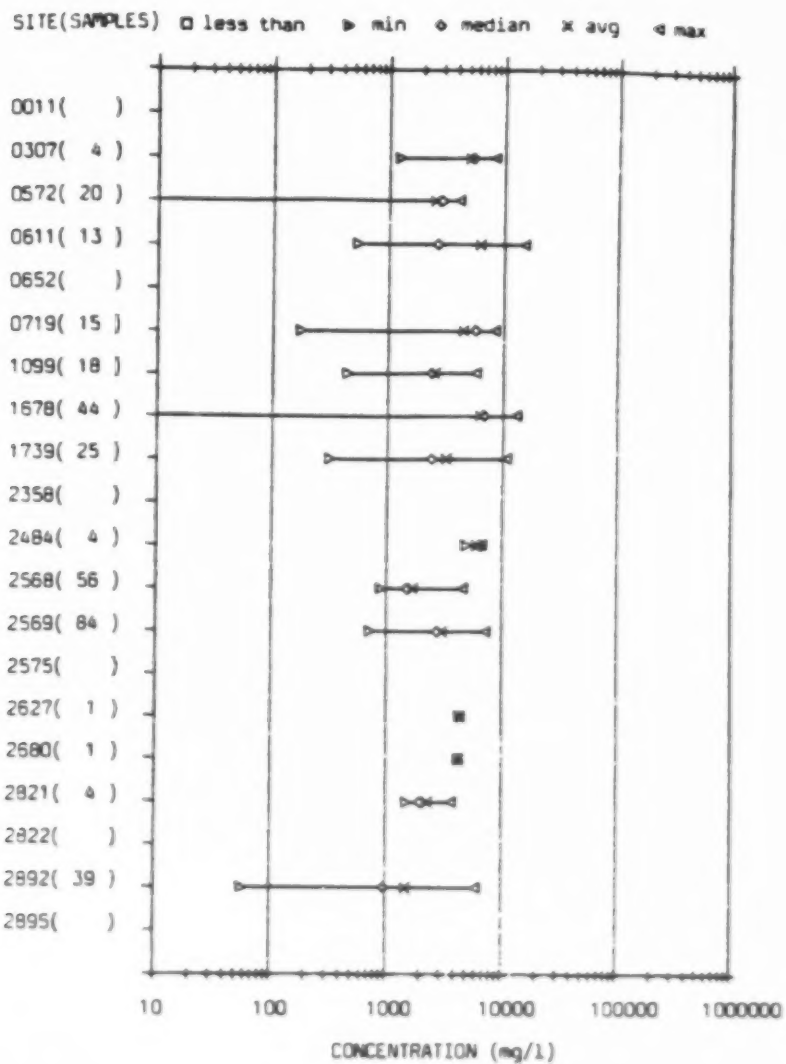


Figure A-6 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Total Alkalinity.

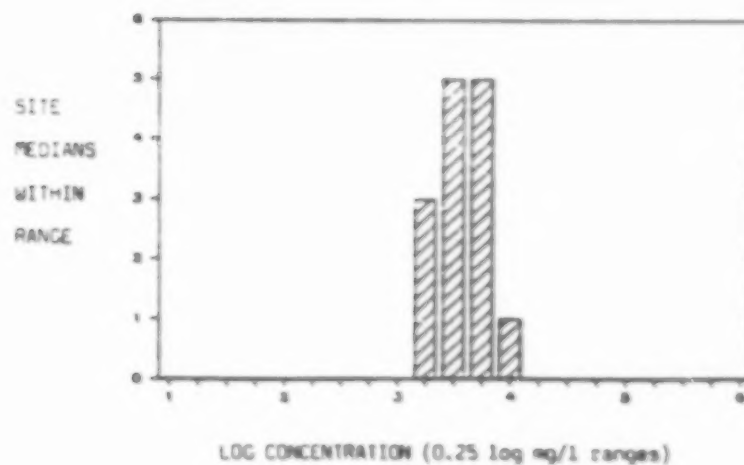
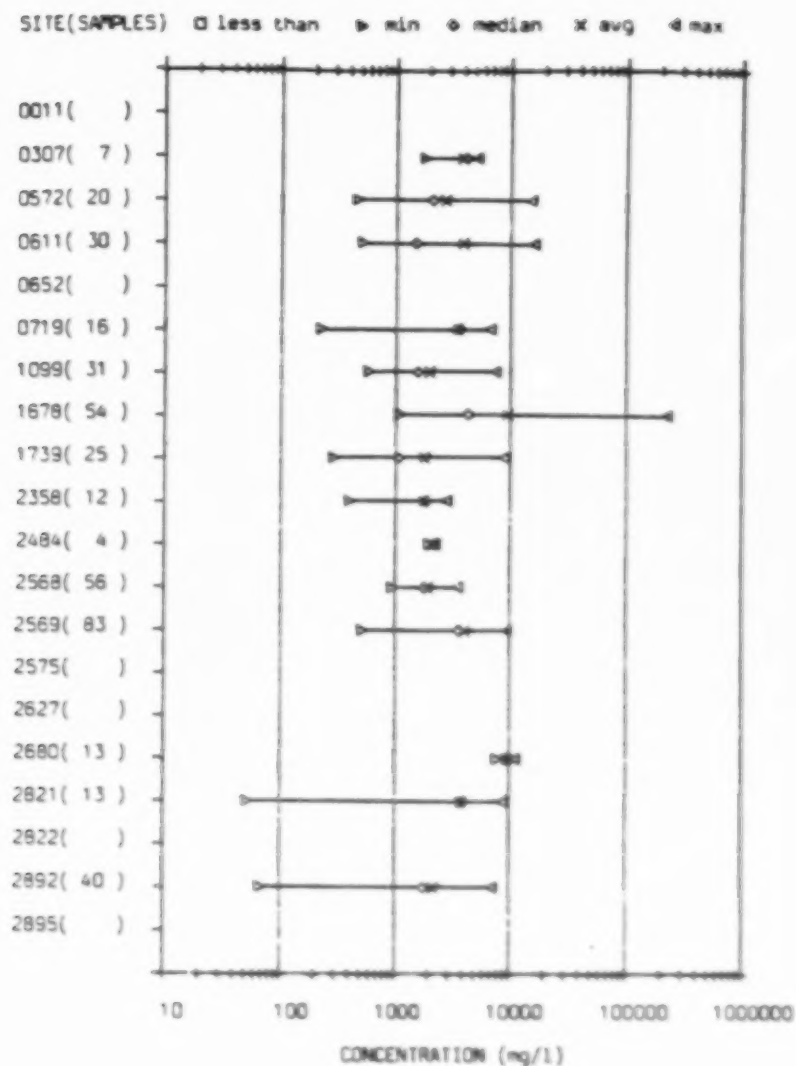


Figure A-7 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Hardness.

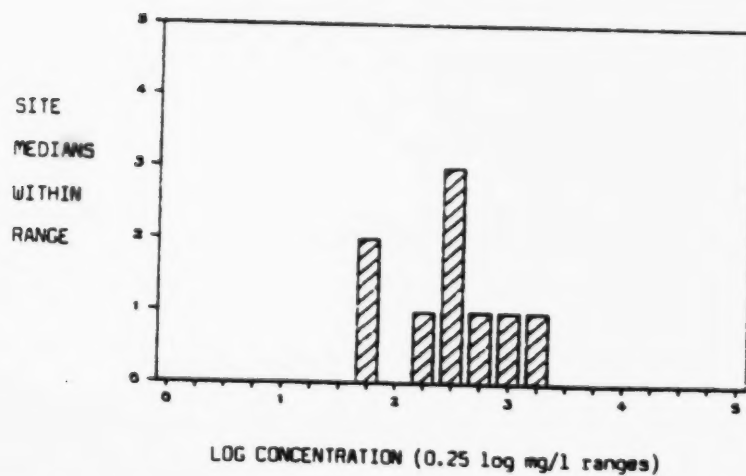
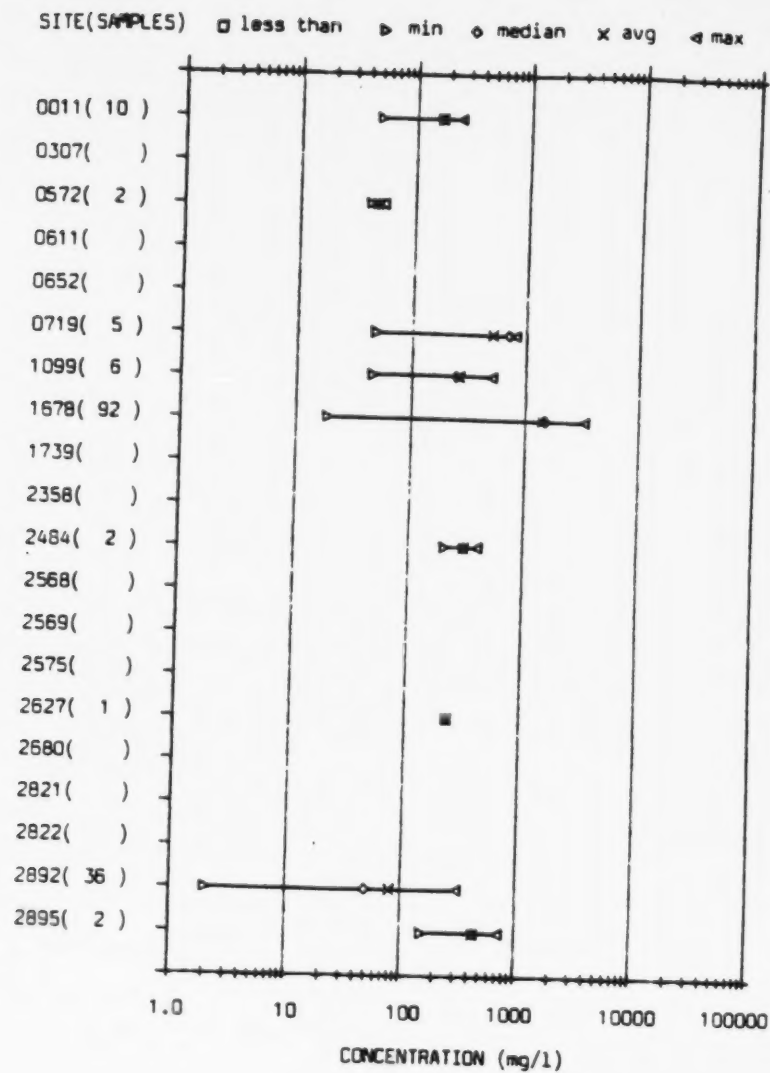


Figure A-8 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Total Kjeldahl Nitrogen.

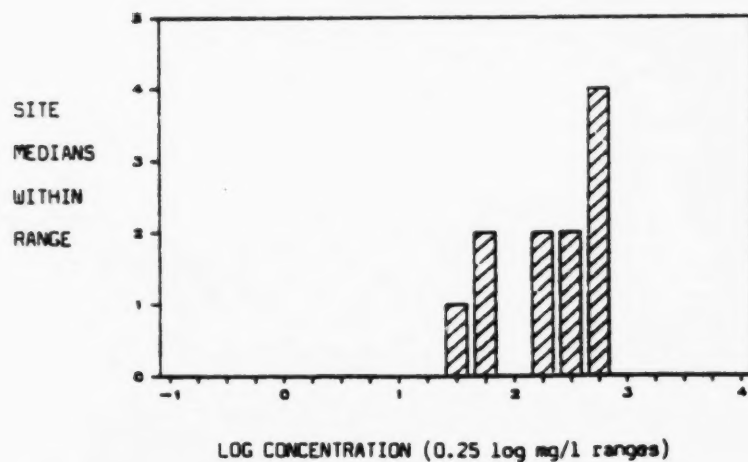
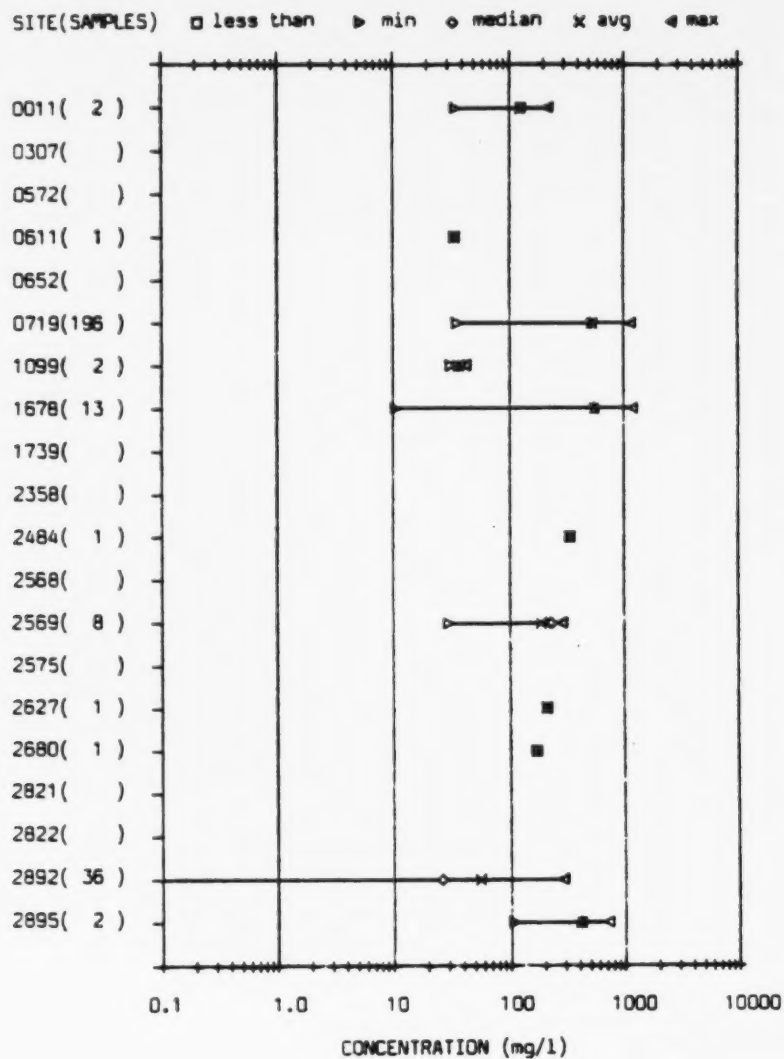


Figure A-9 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Ammonia Nitrogen.

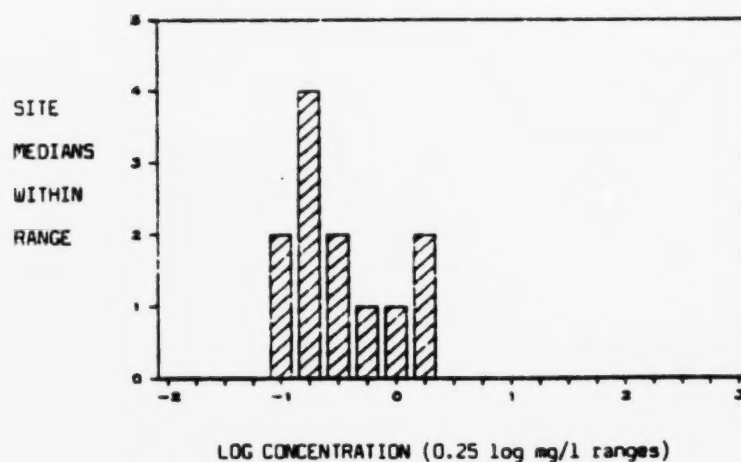
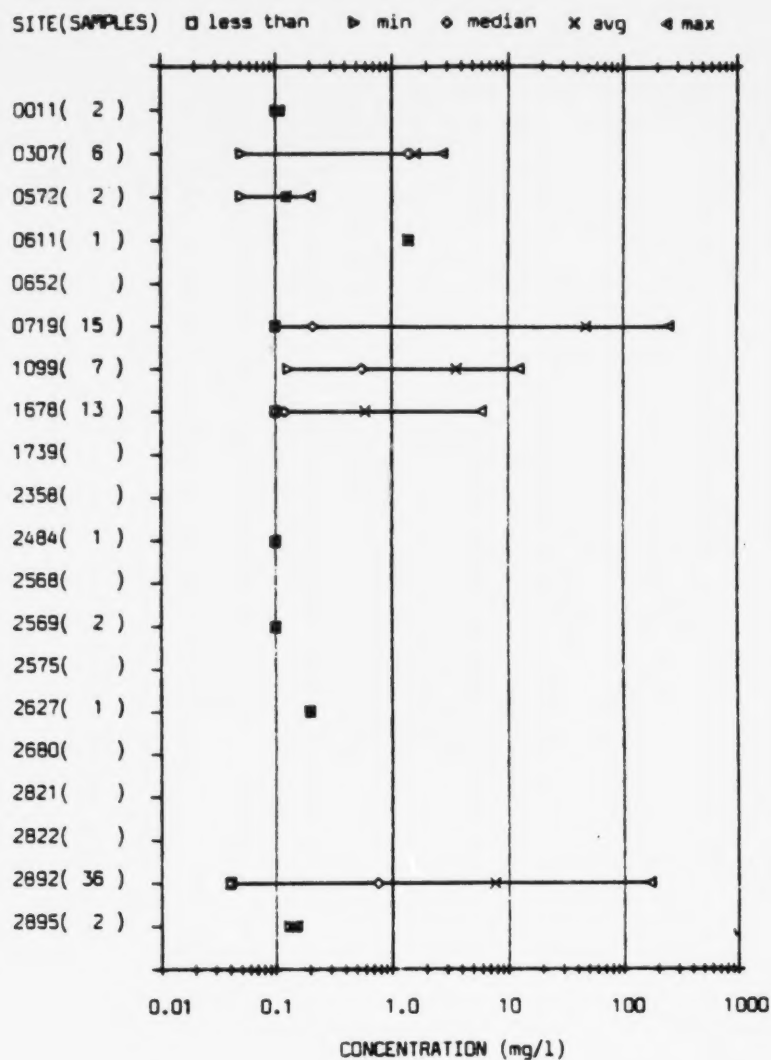


Figure A-10 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Nitrate Nitrogen.

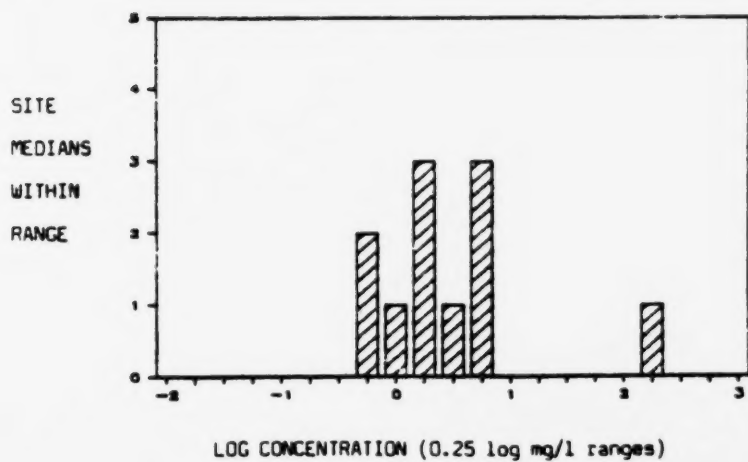
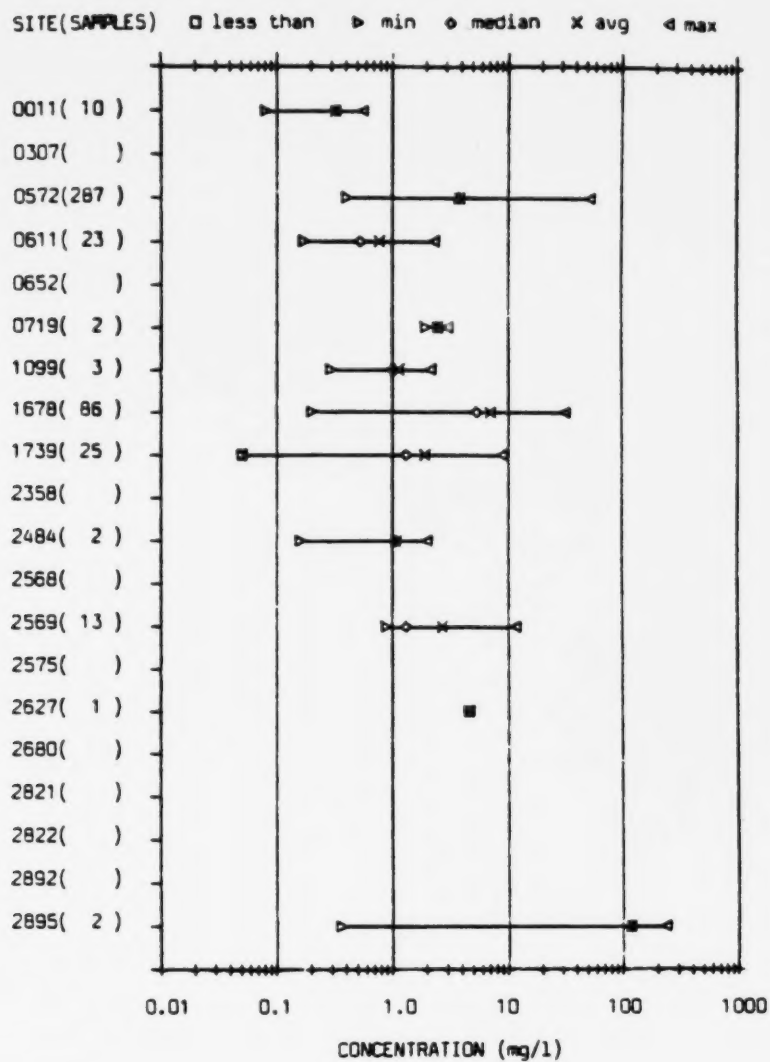


Figure A-11 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Total Phosphorus.

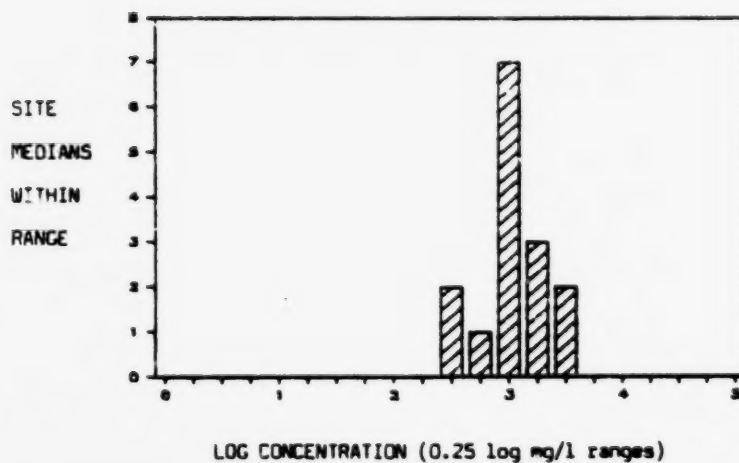
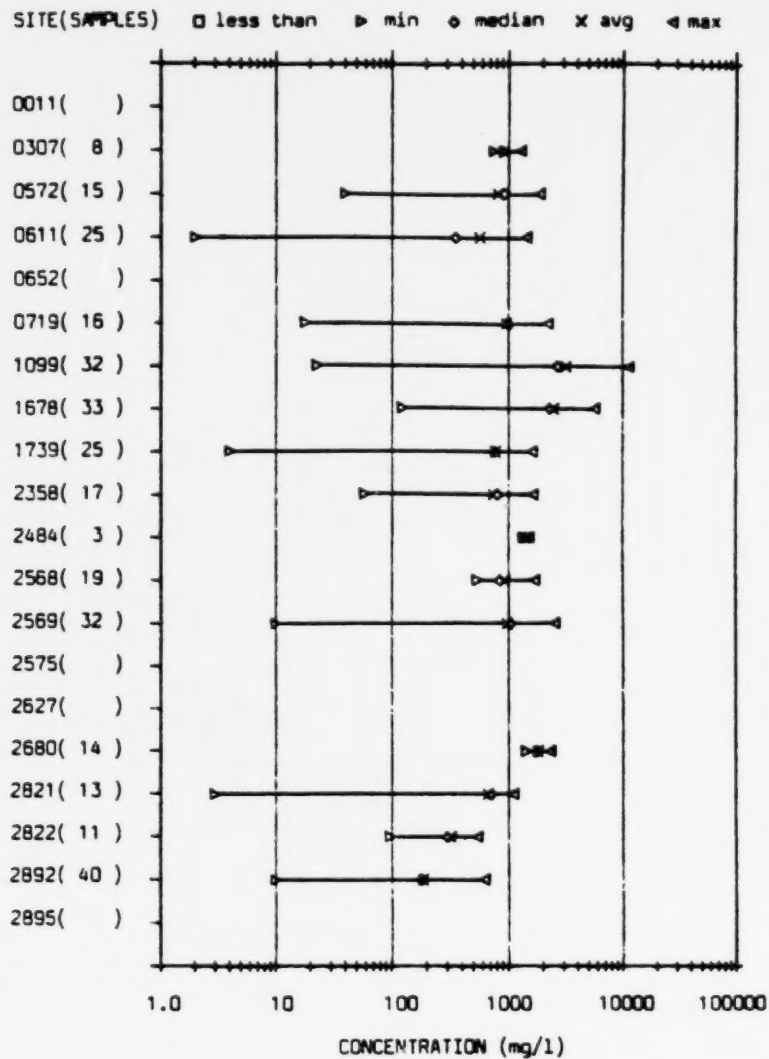


Figure A-12 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Chloride.

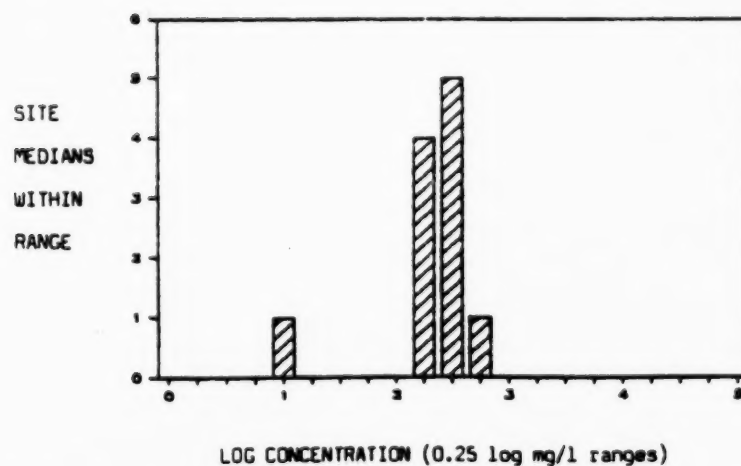
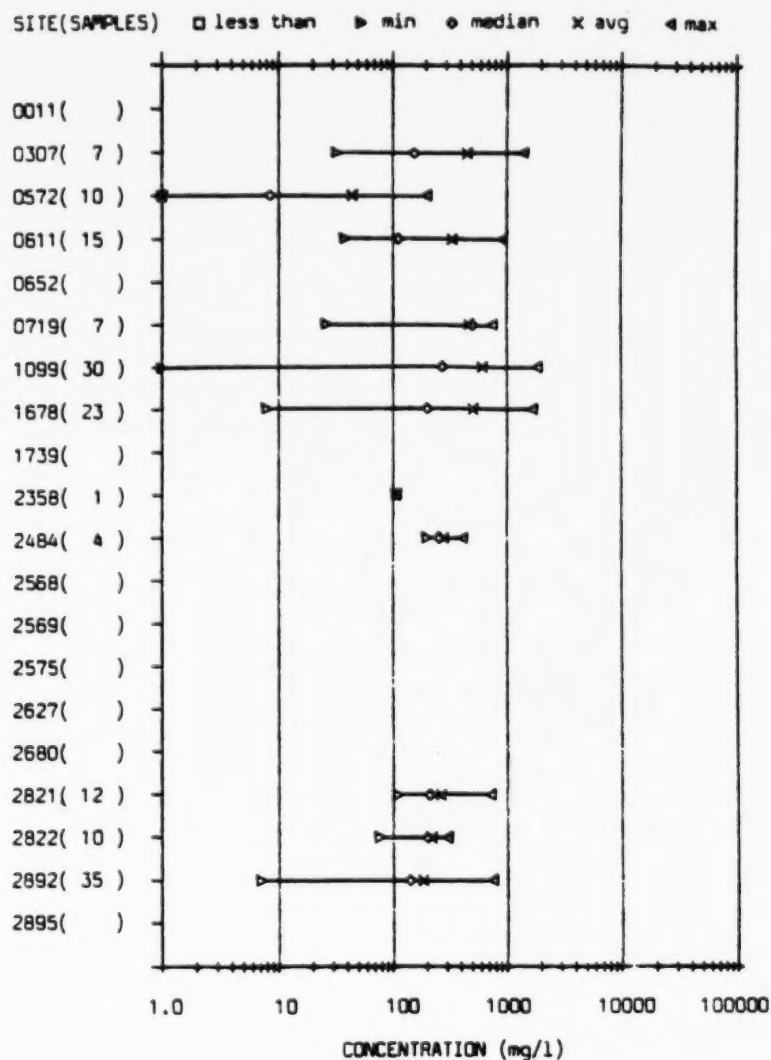


Figure A-13 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Sulfate.

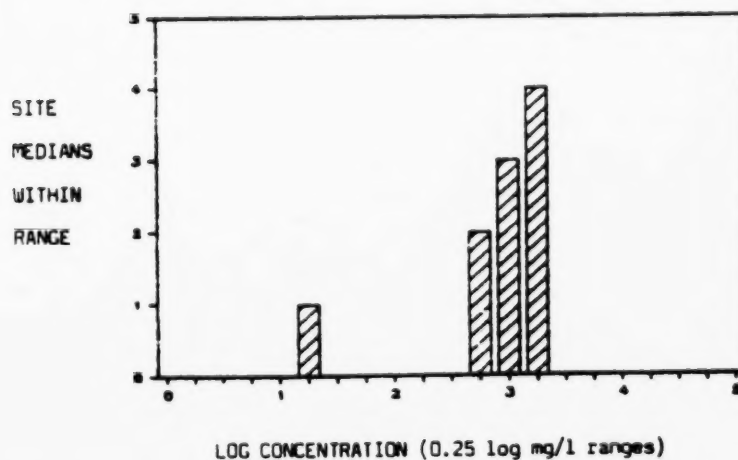
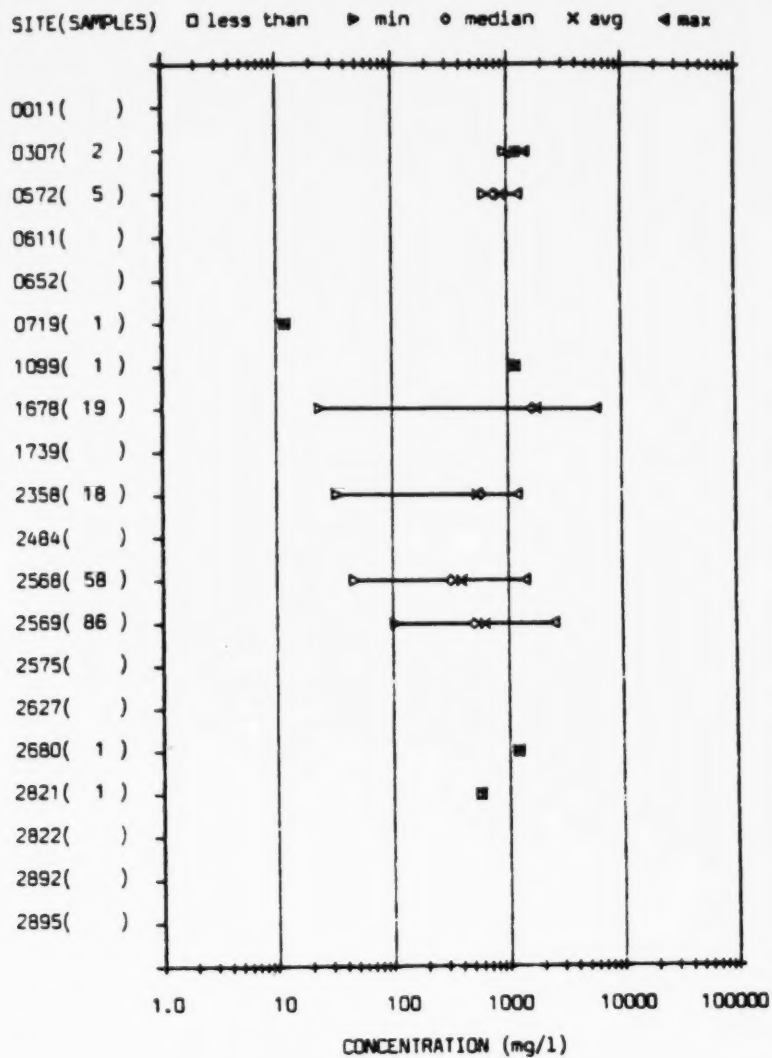


Figure A-14 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Sodium.

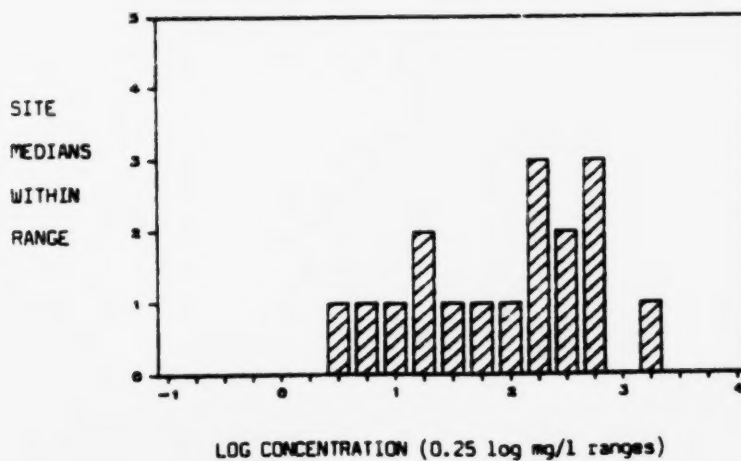
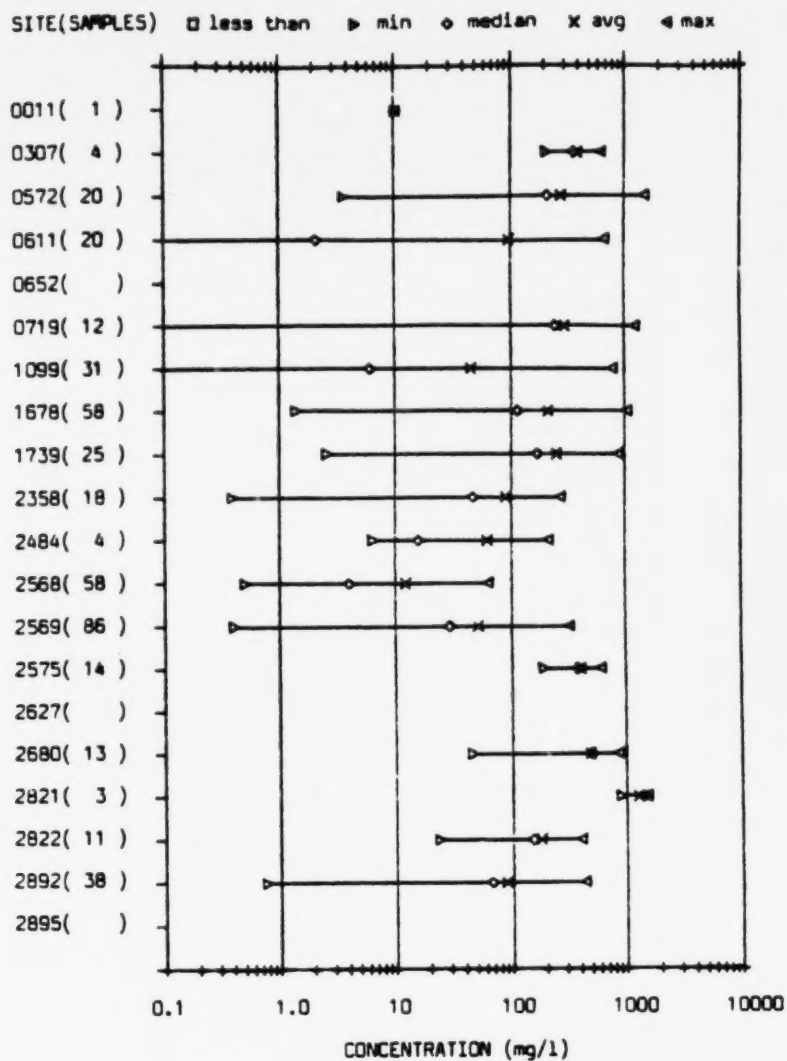


Figure A-15 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Iron.

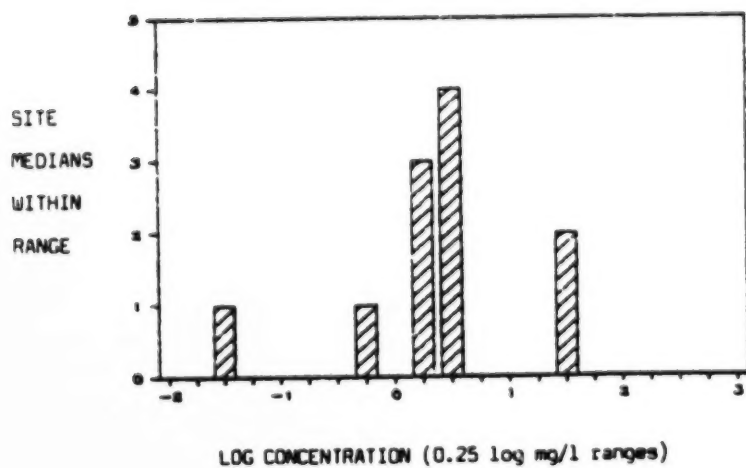
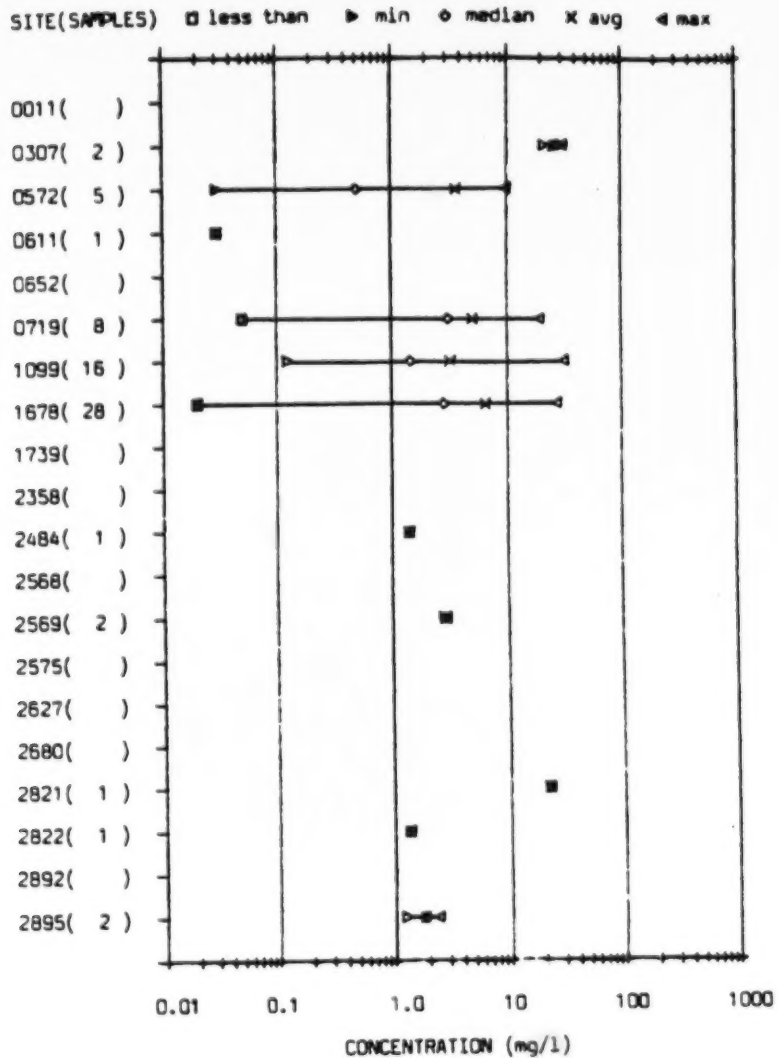


Figure A-16 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Manganese.

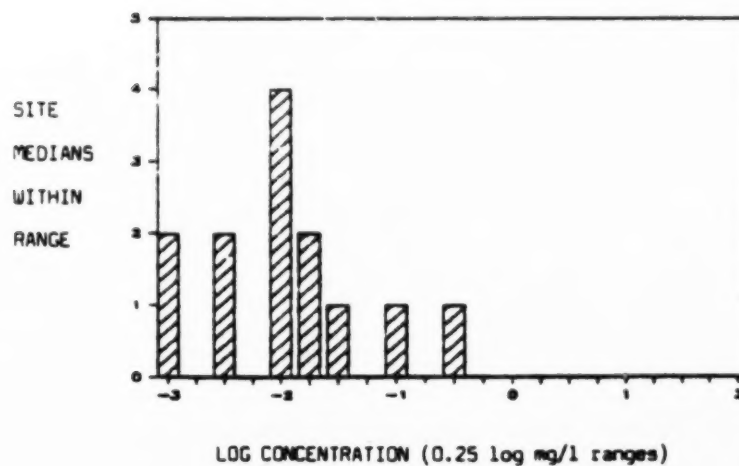
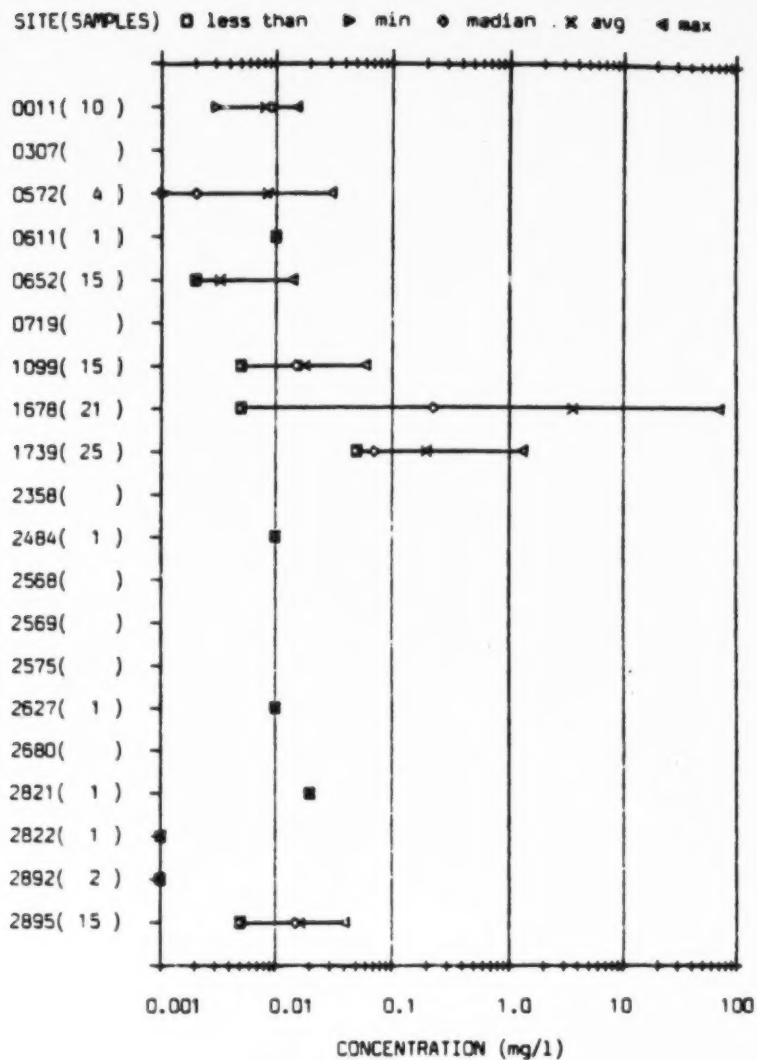


Figure A-17 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Arsenic.

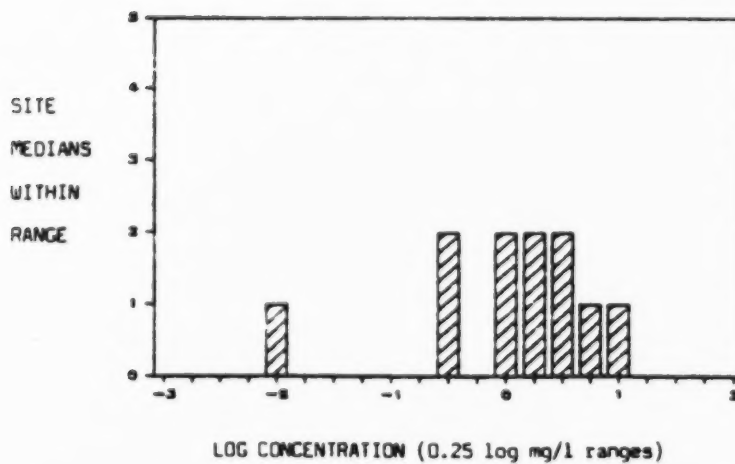
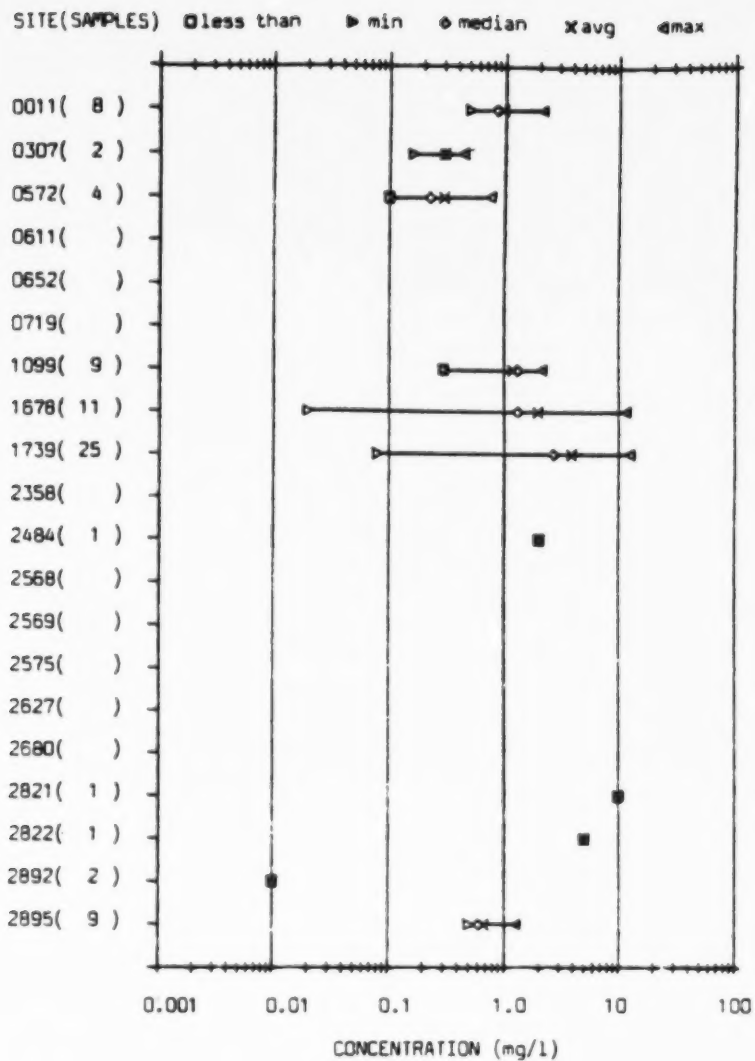


Figure A-18 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Barium.

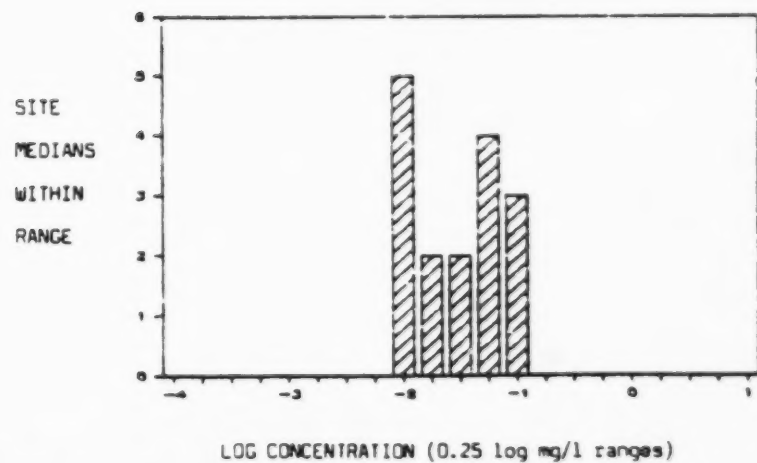
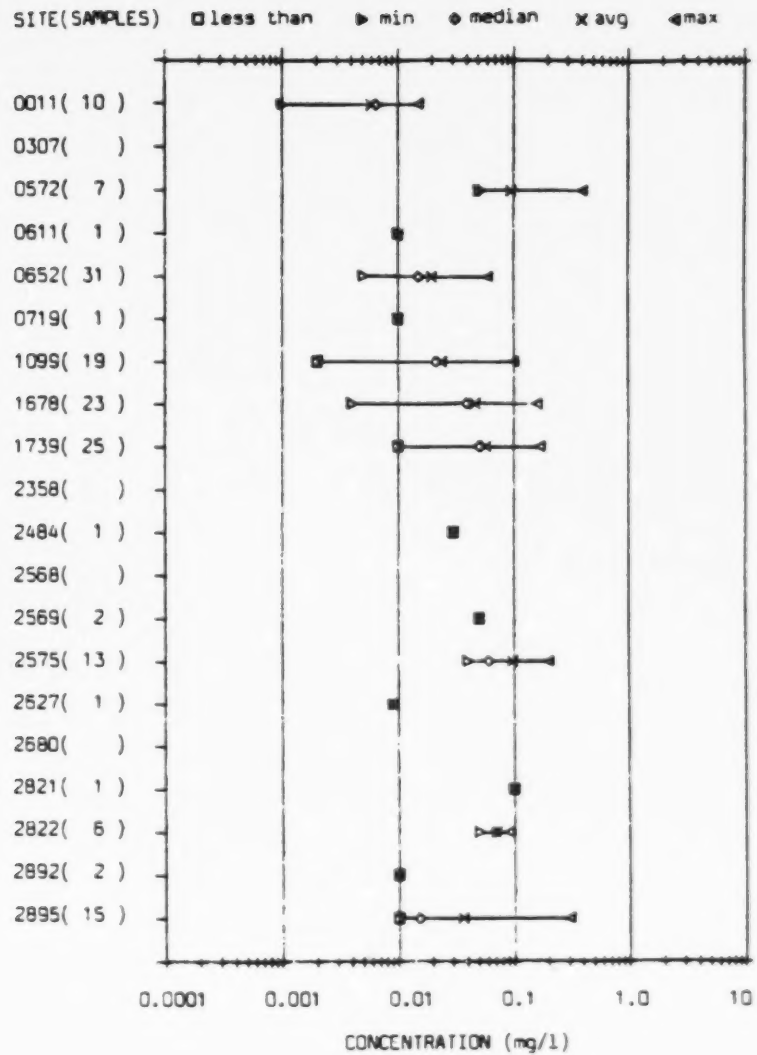


Figure A-19 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Cadmium.

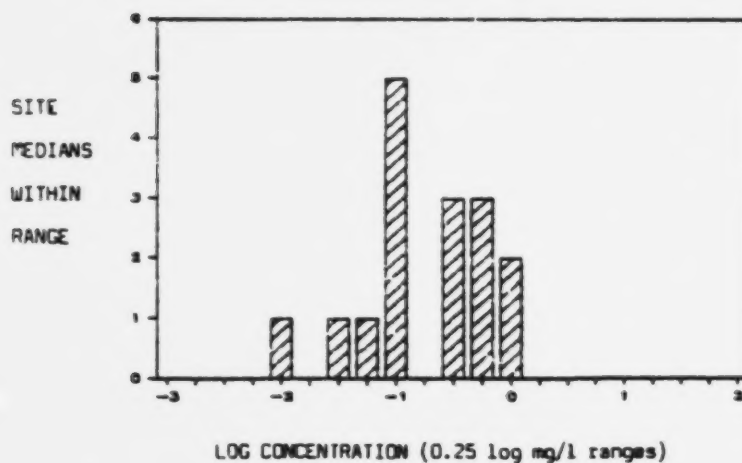
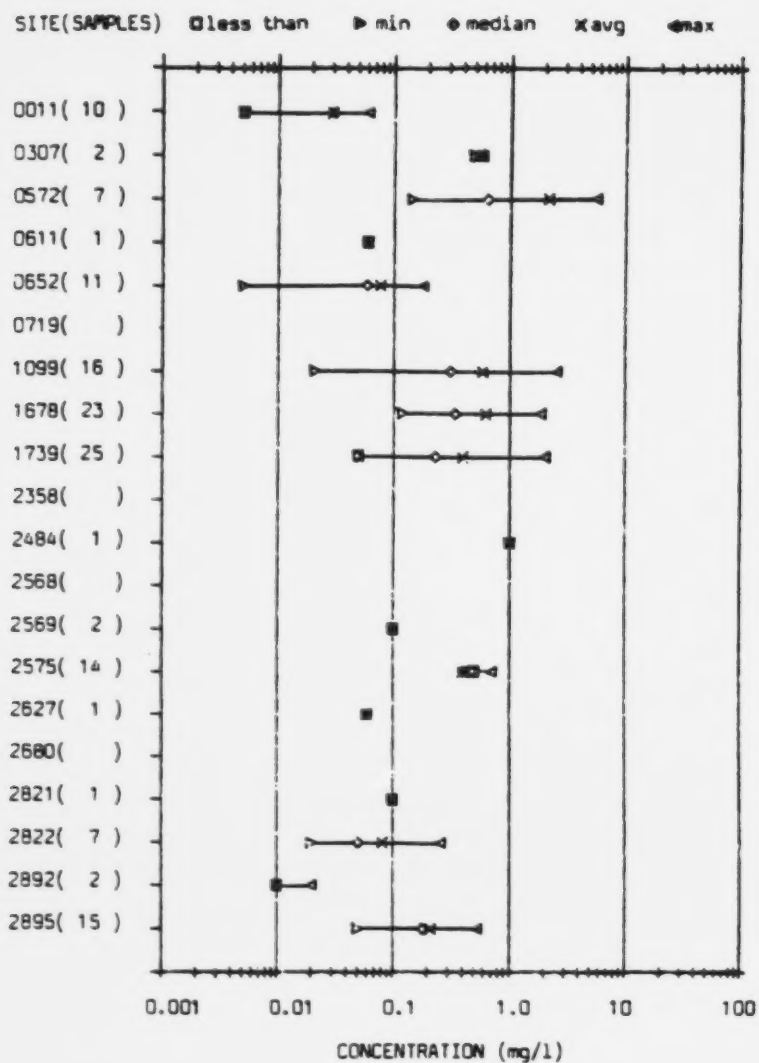


Figure A-20 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Total Chromium.

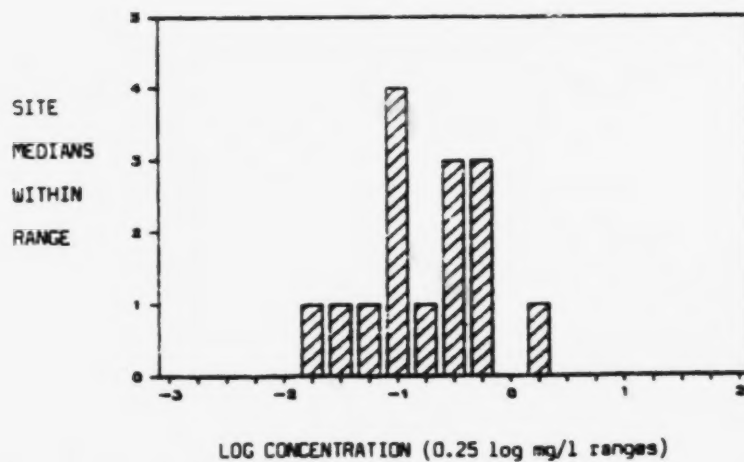
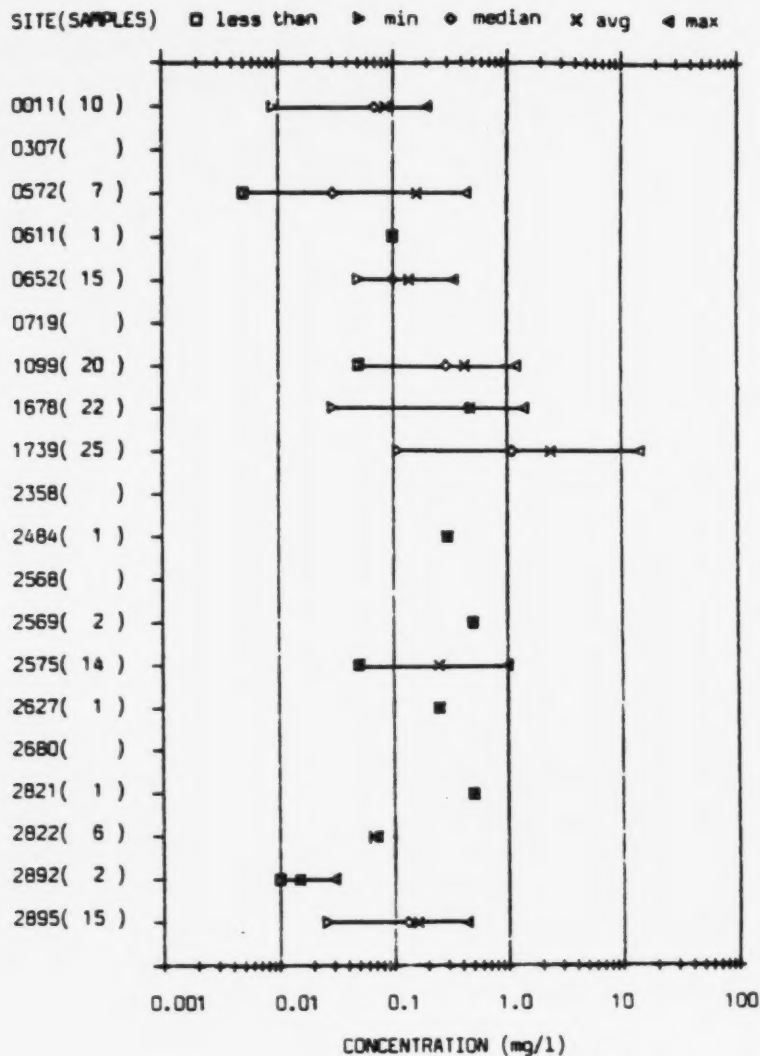


Figure A-21 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Lead.

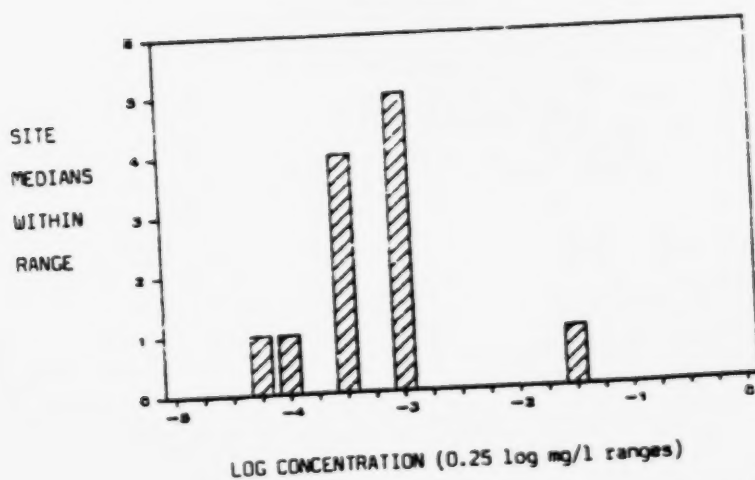
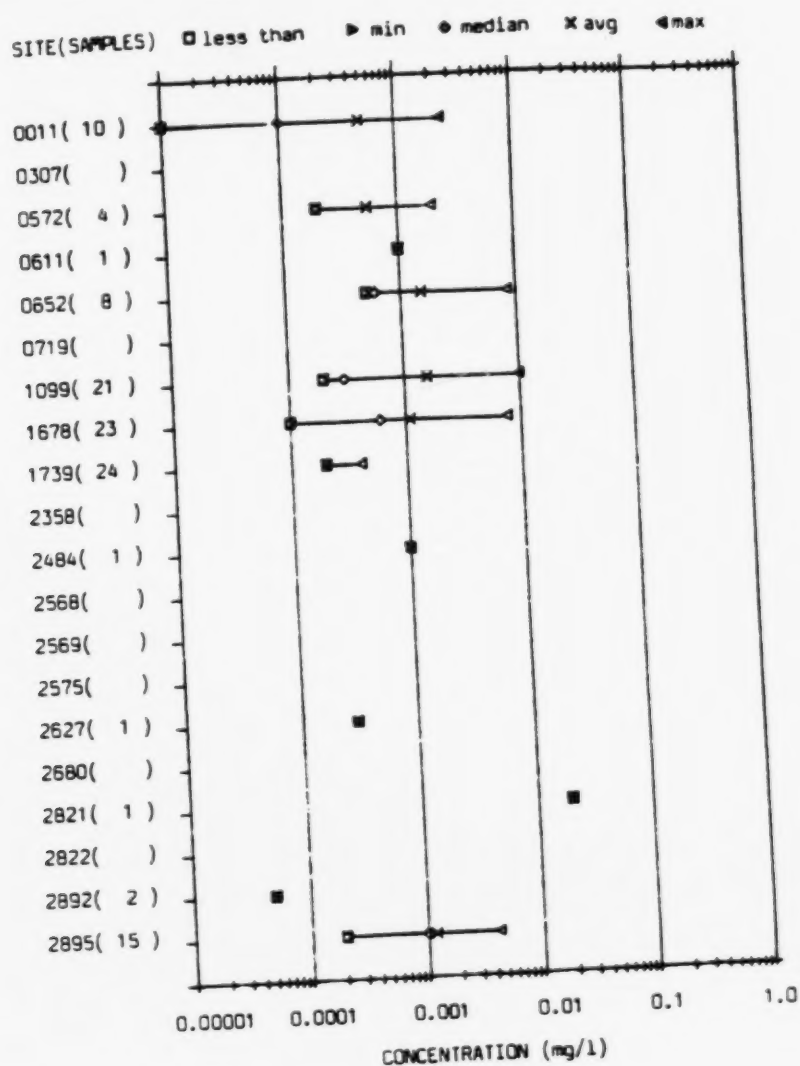


Figure A-22 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Mercury.

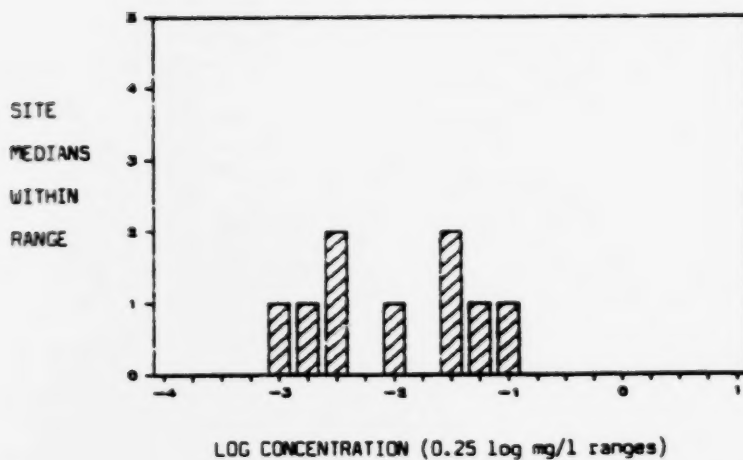
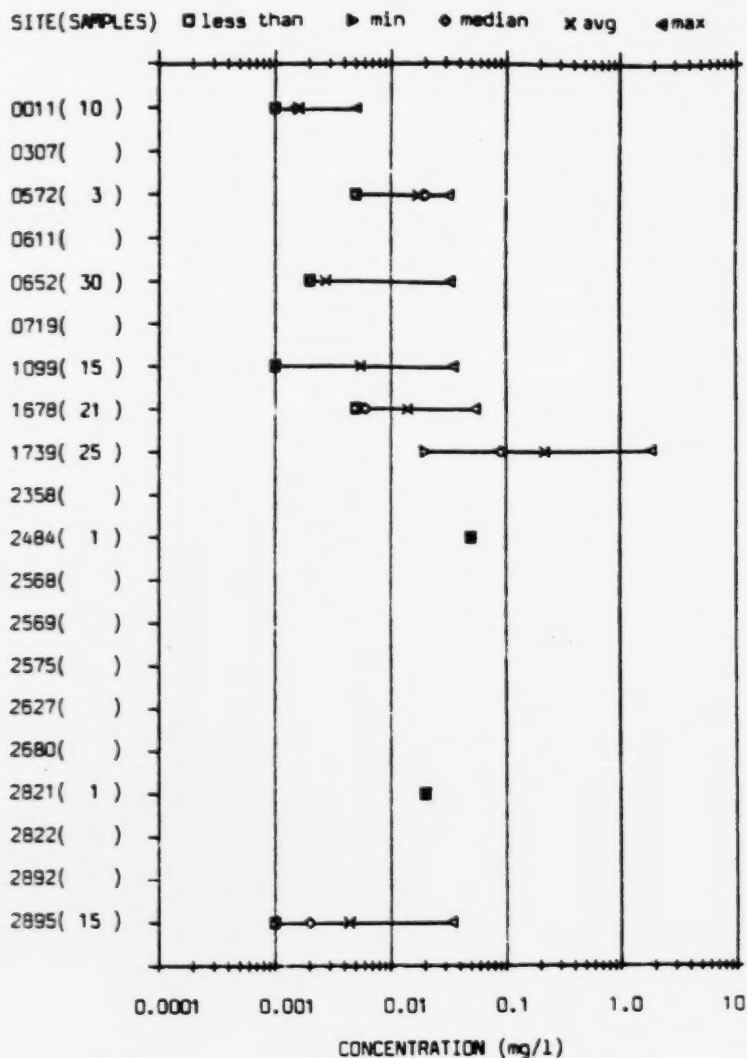


Figure A-23 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Selenium.

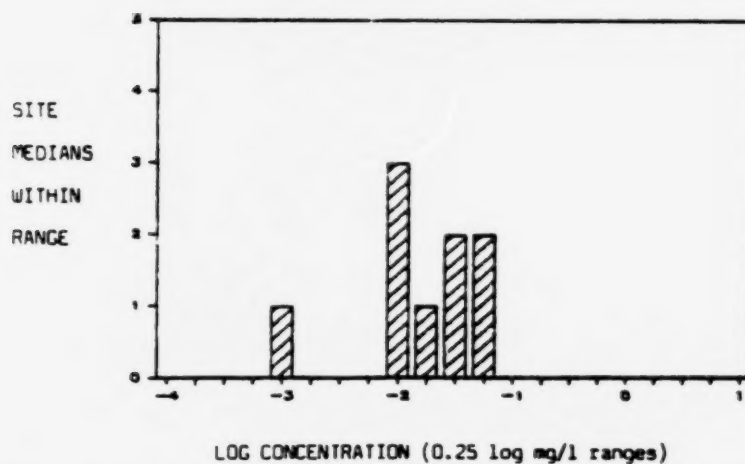
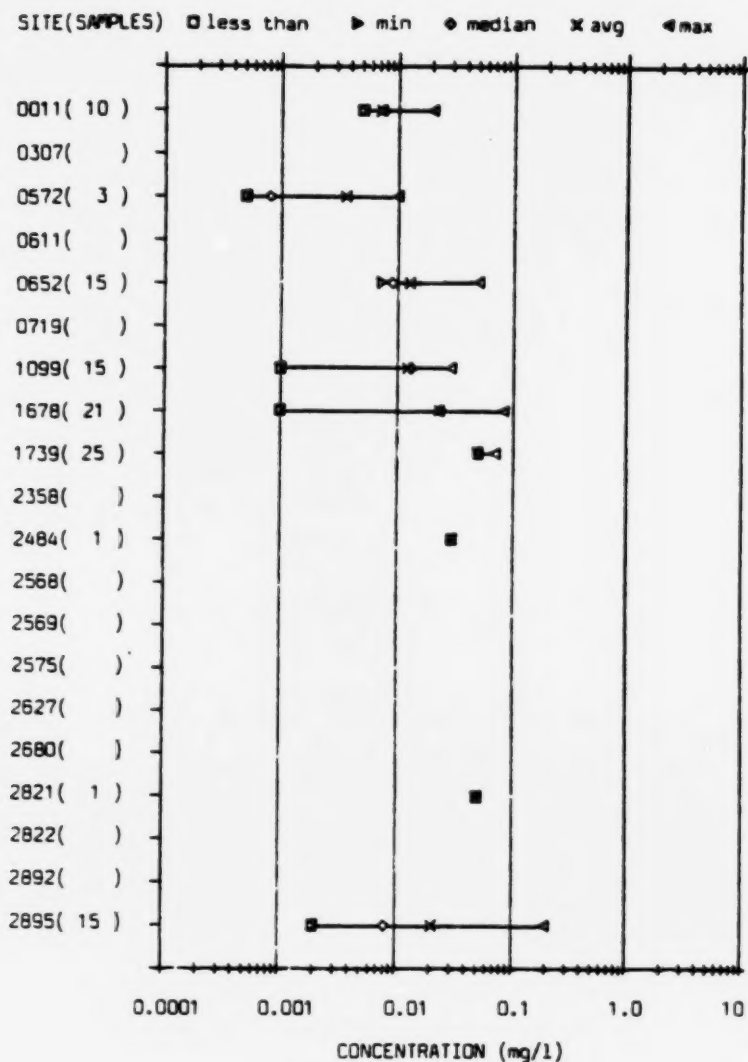


Figure A-24 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Silver.

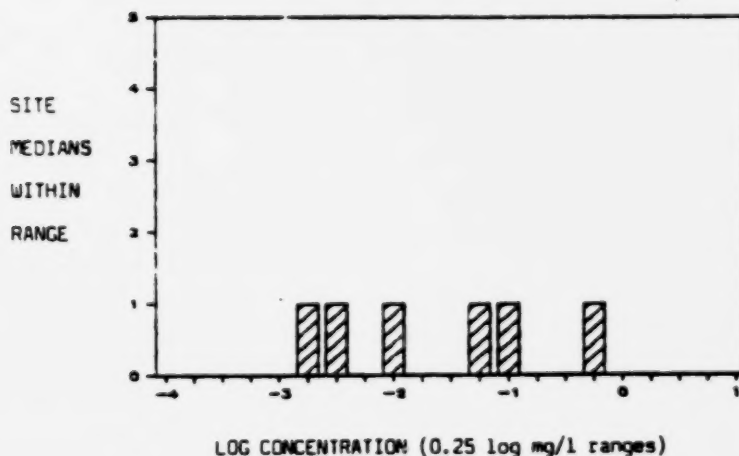
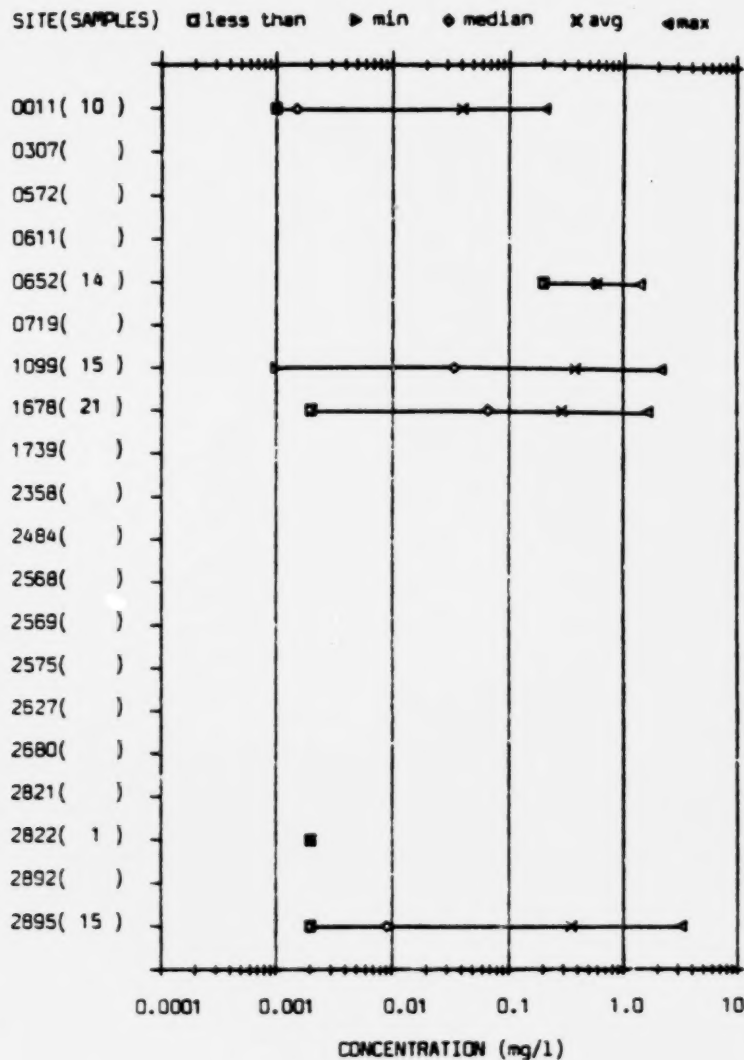


Figure A-25 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Antimony.

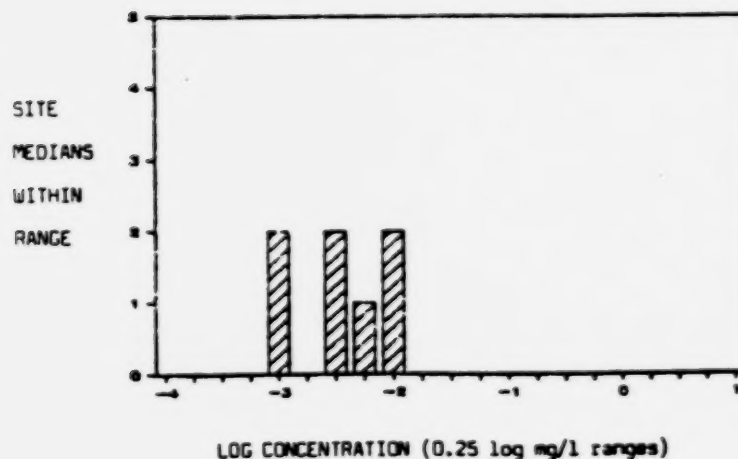
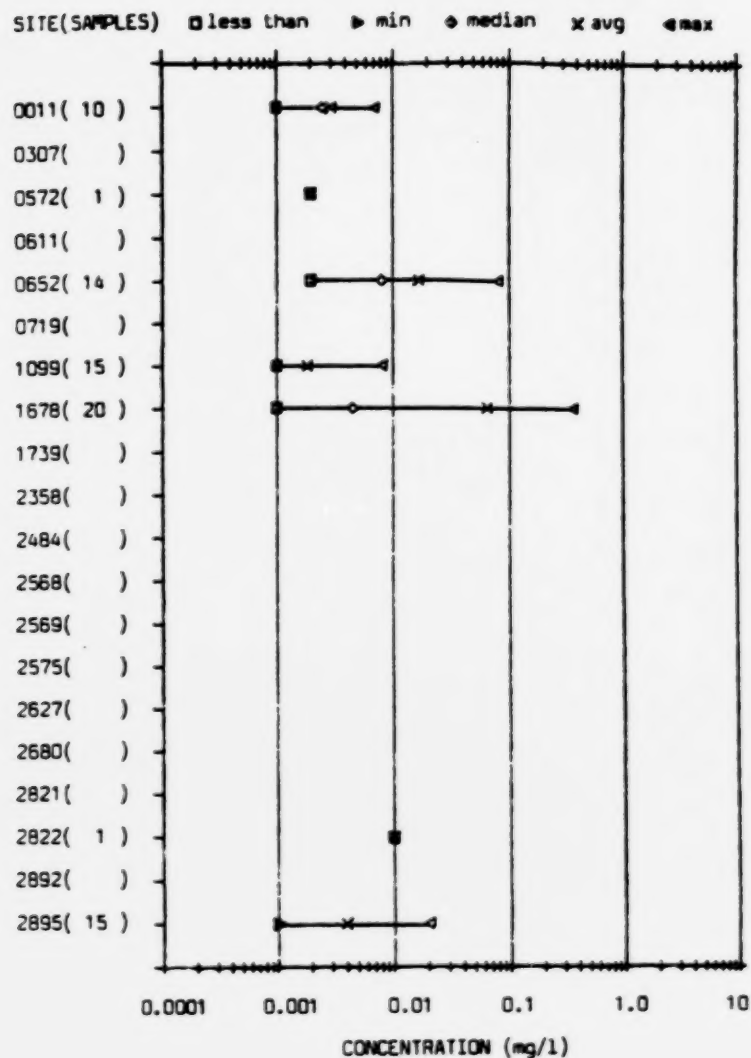


Figure A-26 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Beryllium.

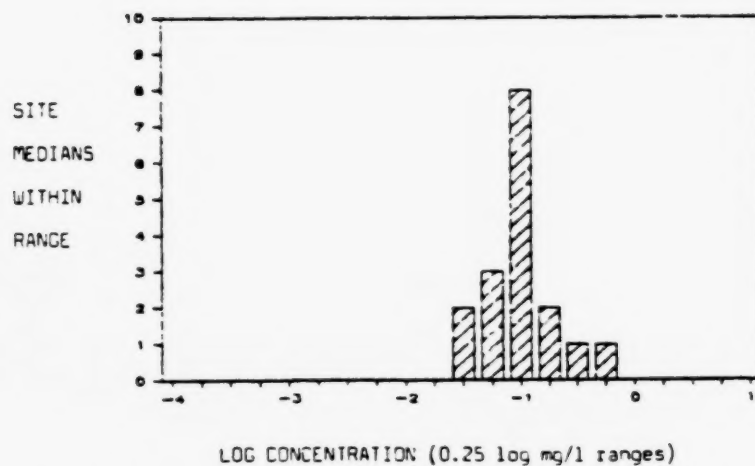
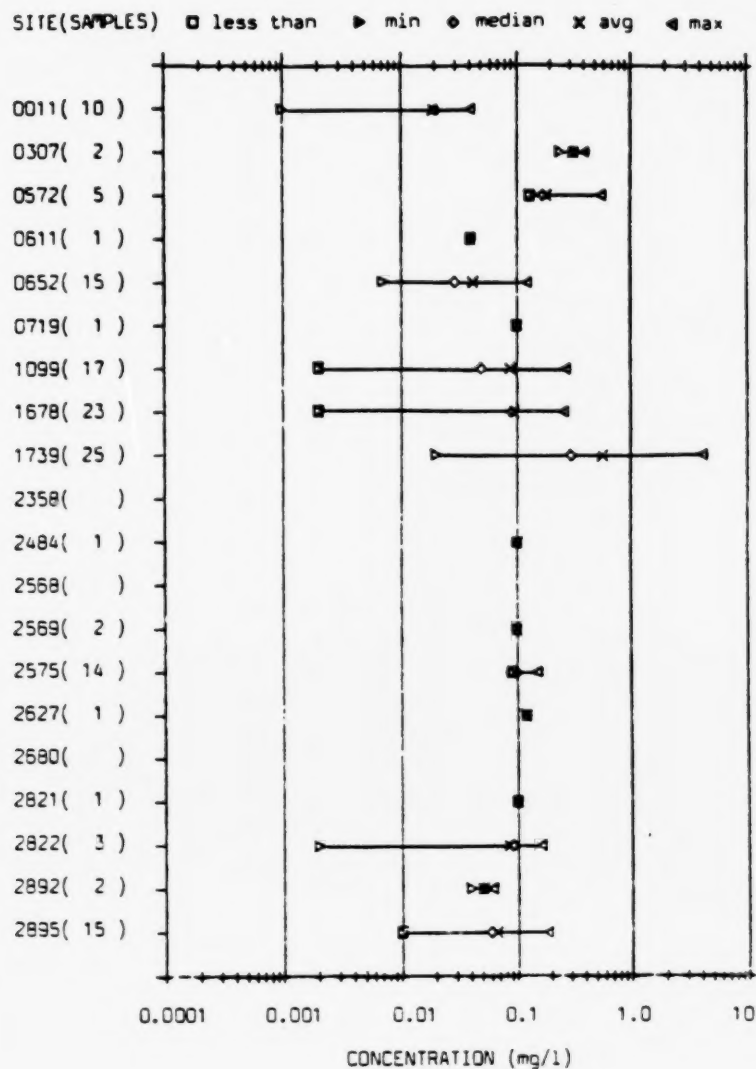


Figure A-27 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Copper.

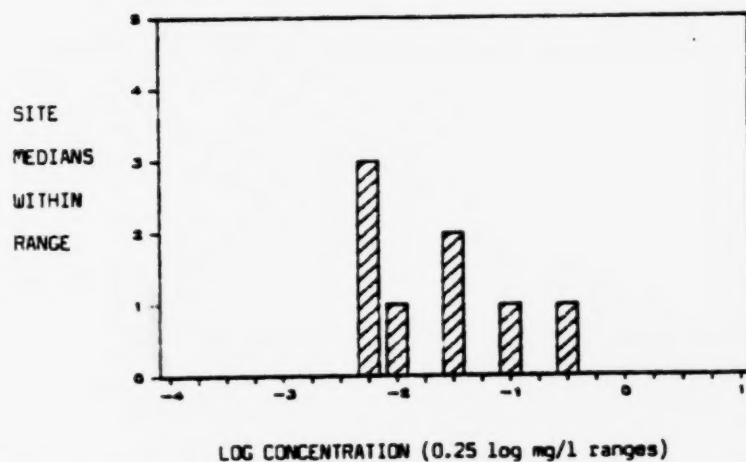
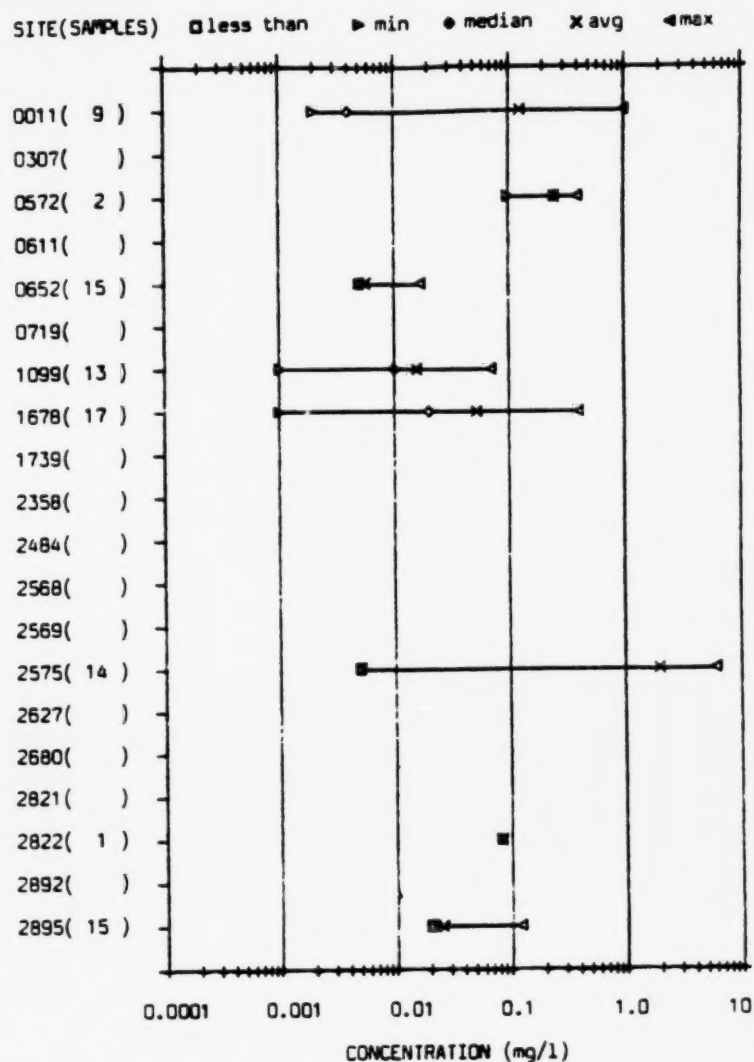


Figure A-28 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Cyanide.

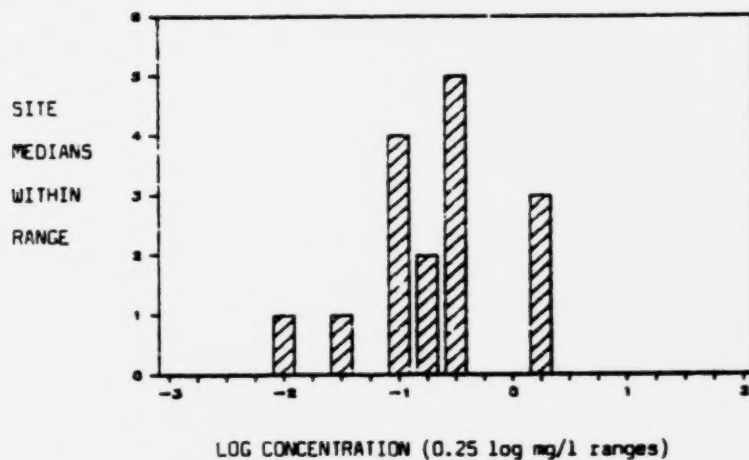
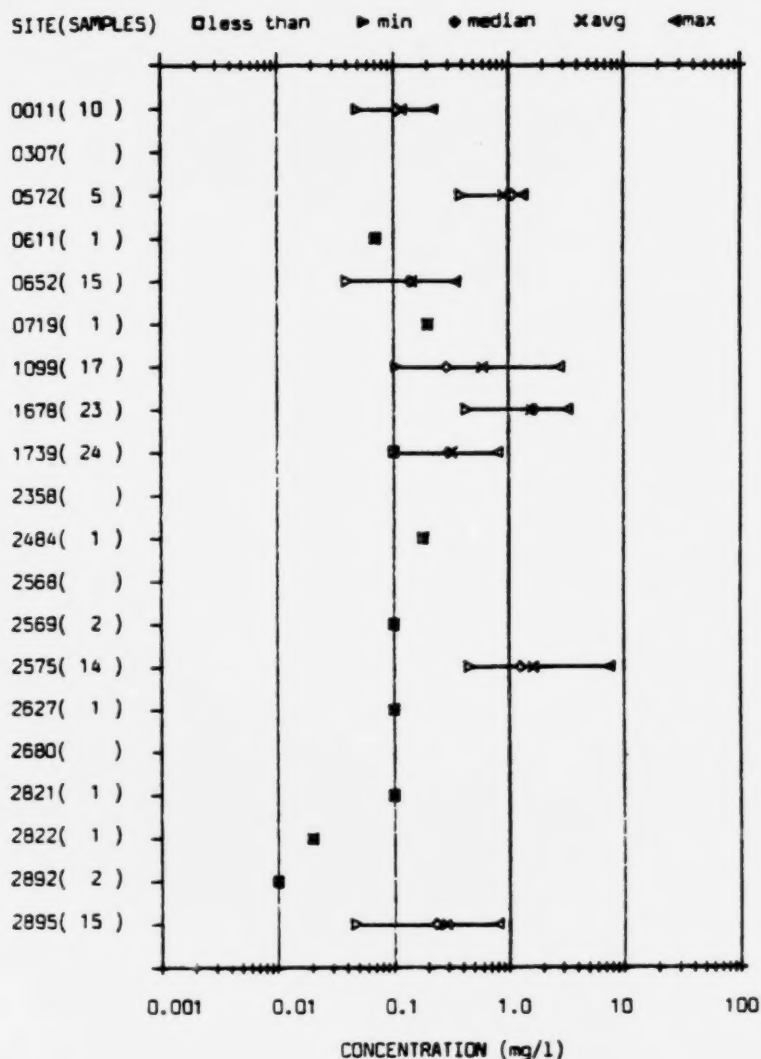


Figure A-29 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Nickel.

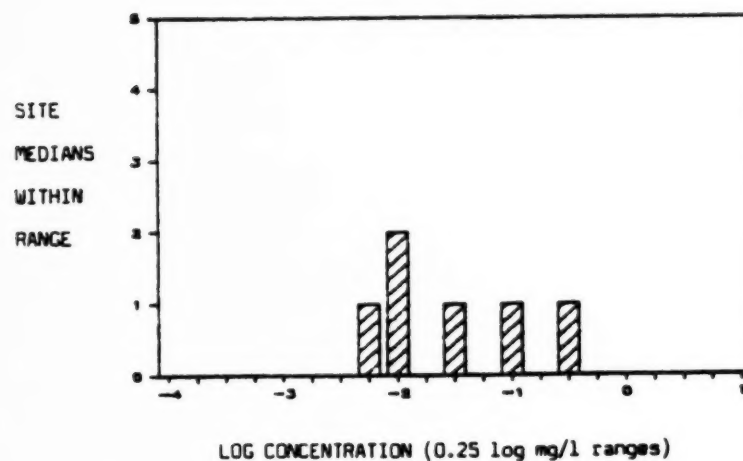
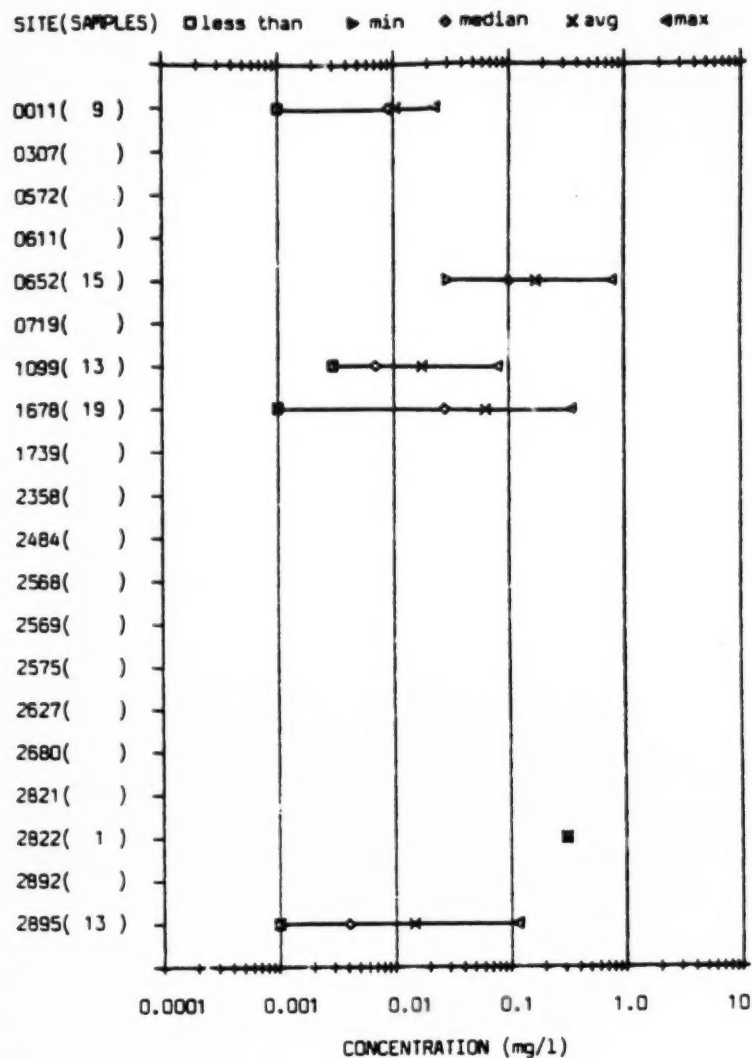


Figure A-30 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Thallium.

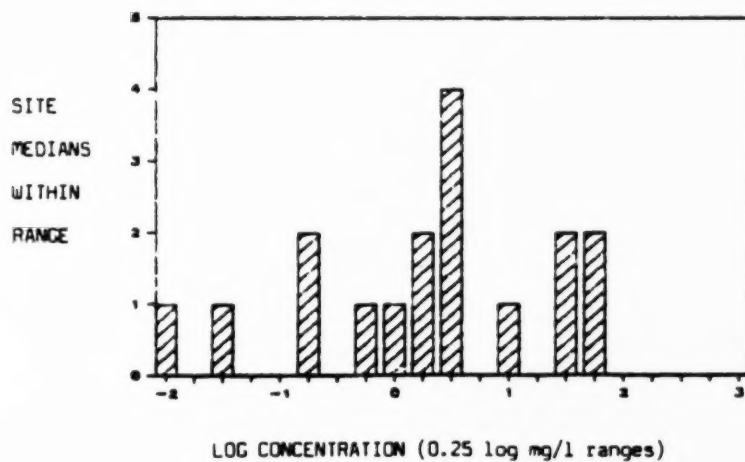
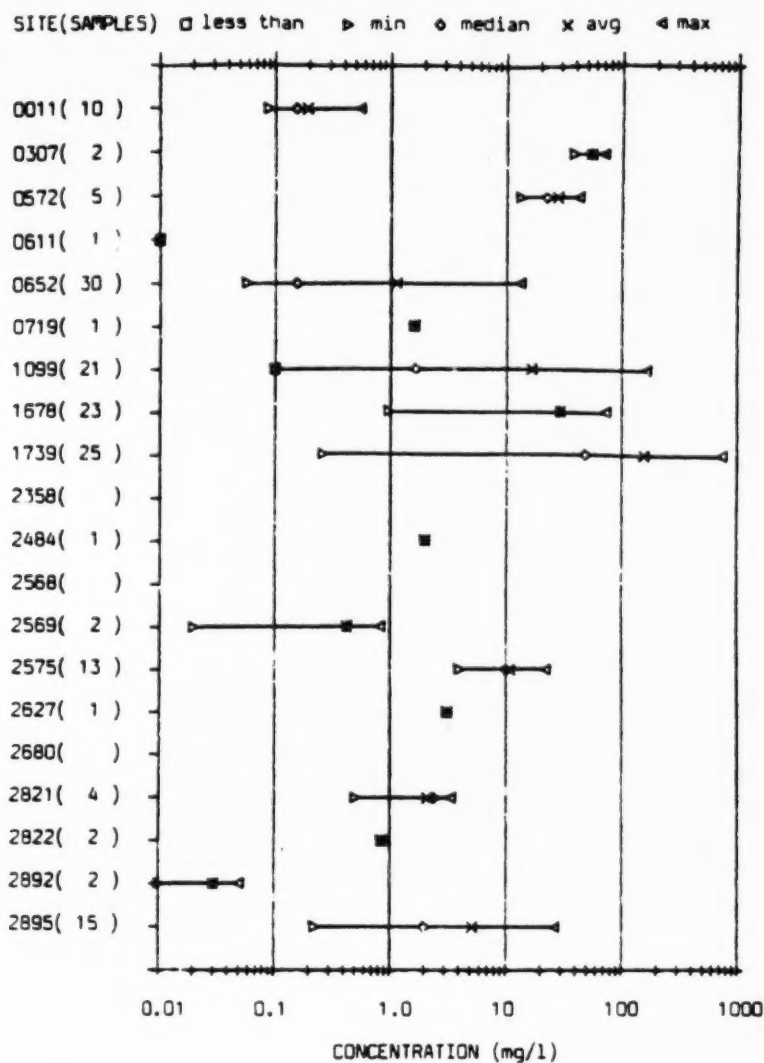


Figure A-31 Range Graph(above) and Median Frequency-of-occurrence Histogram(below) for Leachate Zinc.

Table A-1 Total Leachate Phenol Analysis Results

Site ID	Sample Source (1)	Sample Date	Total Phenol Concentration (mg/l)
0011	CS(M3)	31-Mar-82	0.18
0011	CS(M3)	20-Oct-82	234
0572	CS(M)	24-Jul-79	4.77
0572	HW(B12)	14-Jan-81	112
0572	HW(B20)	14-Jan-81	0.48
0572	HW(B21)	14-Jan-81	0.52
0652	CS(M)	14-Oct-80	9.5
0652	CS(M)	24-Oct-80	20
0652	CS(M)	30-Oct-80	32
0652	CS(M)	18-Nov-80	36
0652	CS(M)	16-Dec-80	28
0652	CS(M)	15-Jan-81	24.2
0652	CS(M)	08-Apr-81	2.9
0652	CS(M)	08-Jul-81	16
0652	CS(M)	30-Sep-81	11
0652	CS(M)	28-Dec-81	6.3
0652	CS(M)	04-Mar-82	8.9
0652	CS(M)	09-Jun-82	6.5
0652	CS(M)	19-Sep-82	1.9
0652	CS(M)	06-Dec-82	2.73
0652	CS(M)	24-Mar-83	17.23
1099	CS(M1A)	07-Apr-82	0.246
1099	CS(R2)	06-Apr-82	0.145
1099		19-Dec-80	3.8
1678	CS(R6)	20-Oct-82	15.3
1678	CS(R5)	20-Oct-82	3.0
1678	CS(R2)	20-Oct-82	18.5
1678	CS(M1)	20-Oct-82	6.79
1678	CS(M1)	27-Apr-82	3.84
1678	CS(R5)	31-Mar-82	8.47
1678	CS(R2)	31-Mar-82	16.0
1678	CS(c)	19-Dec-80	18.0
2627		22-May-81	5.2
2822		25-Nov-81	8.36
2895	CS	19-Dec-80	2.5
2895	CS(R3)	19-Dec-80	0.438
2895	CS(T)	19-Dec-80	1.1

(1): Abbreviations

CS: Collection System(R-Riser,
 MH-Manhole, T-Tank, c-Composite Sample)
 HW: Headwell

Source: Wisconsin Department
 of Natural Resources Report

Table A-2 Leachate Analysis Results for Polychlorinated Biphenyls, Pesticides and Herbicides

Compound	Number of Leachate Analysis	Number of Samples with a Detectable Concentration (det limit <10ppb)	Sites where Detected (conc range) (ppb)
Polychlorinated Biphenyls			
1242	18	0	
1254	18	0	
1221	18	0	
1232	15	0	
1248	18	0	
1260	18	0	
1016	18	1	1099(2.8)
Unspecific	27	3	1739(6.9-310)
Chlorinated Hydrocarbon Insecticides			
Aldrin	21	0	
Alpha-BHC	18	0	
Beta-BHC	18	0	
Gamma-BHC	21	0	
Delta-BHC	18	1	2822(4.6)
BHC	3	0	
Chlordane	20	0	
DDT	21	0	
DDE	21	0	
DDD	21	0	
Dieldrin	21	0	
Endosulfan(a and b)	20	0	
Endosulfan Sulfate	19	0	
Endrin	23	0	
Endrin Aldehyde	20	0	
Heptachlor	21	0	
Heptachlor Epoxide	21	0	
Toxaphene	22	0	
Methoxychlor	1	0	
Mirex	1	0	
Organophosphorus Insecticides			
Methylparathion	1	0	
Ethylparathion	1	0	
Chlorophenoxy Herbicides			
2,4-D	2	2	572(7), 1099(1800)
2,4,5-TP	2	0	
2,3,7,8-TCDD	1	0	

Includes data from sites: 11,572,719,1099,1678,1739,2568,2569,2627,2822,2895.

Source: Wisconsin Department of Natural Resources Report

Table A-3 Typical Orders-of-Magnitude Concentration Ranges Of
Contaminants in Municipal Solid Waste Landfill Leachates in Wisconsin

<u>mg/l Range</u>	<u>Parameters</u>
1,000 - 100,000	BOD, COD, Alkalinity, Hardness, TDS
100 - 1,000	TSS, Total-N, Chlorides, Sulfates, Sodium, Iron
10 - 100	Zinc
1.0 - 10	Manganese, Total-P, Barium
0.1 - 1.0	Nitrate-N, Chromium, Lead, Copper
0.01 - 0.1	Arsenic, Cadmium, Selenium, Silver, Antimony, Cyanide, Nickel, Thallium
0.001 - 0.01	Beryllium
0.0001 - 0.001	Mercury

Source: Wisconsin Department of Natural Resources Report

APPENDIX B
WISCONSIN CASE HISTORY INFORMATION

TABLE B-1

WISCONSIN CASE HISTORY INFORMATION

Site Number: 0011
Site Name: WMI-Lauer I, WI
Site Type: Zone-of-saturation
Total Design Volume (million cubic yards): Not available
Principal Waste Types: MSW, IND
Date Filling Began: pre-1960
Site Size (Acres): 38

- Leachate barium concentrations exceeded the drinking water standard of 1 mg/l

Site Number: 0307
Site Name: WMI-Polk, WI
Site Type: Clay Lined
Total Design Volume (million cubic yards): 0.5
Principal Waste Types: MSW
Date Filling Began: 1970
Site Size (Acres): 9

- Older site - lower and more consistent suspended solids concentrations.
- Leachate oxygen demand medians greater than 20,000 mg/l.
- Median chromium concentrations above 0.2 mg/l.
- Aluminum concentrations of 4.5 and 5.6 mg/l.

Site Number: 0572
Site Name: Land Reclamation, WI
Site Type: Zone-of-saturation
Total Design Volume (million cubic yards): 9.5
Principal Waste Types: MSW, IND, HAZ
Date Filling Began: pre-1970
Site Size (Acres): 82

- Patterns of leachate oxygen demand over time, complicated by operational conditions.
- Chromium concentration above 1.5 mg/l.
- Median selenium concentrations exceed drinking water standard.
- Median cyanide concentration of 0.25 mg/l (maximum cyanide concentration in drinking water is 0.2 mg/l).
- Leachate nickel concentrations exceeded 1 mg/l.
- Leachate aluminum concentration below 1 mg/l.

- The 1,2 isomer of dichloroethane was detected.
- Halogenated ethers and aliphatics detected more frequently than the other landfills.
- Herbicide 2,4-D detected: 7 µg/l - Primary drinking water standard is 100 µg/l.
- 42% of the suspended solids were volatile.

Site Number: 0611

Site Name: Winnebago Co., Winnebago, WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 5.5

Principal Waste Types: MSW, IND

Date Filling Began: pre-1970

Site Size (Acres): 94

- Site with one of the lower leachate nitrogen (200-500 mg/l) concentrations.
- Weakest leachate for specific conductance.

Site Number: 0652

Site Name: Tork, WI

Site Type: Retrofit

Total Design Volume (million cubic yards): 1.5

Principal Waste Types: MSW, IND

Date Filling Began: 1970

Site Size (Acres): 38

- More dilute leachate - lower and more consistent suspended solids concentrations.
- Leachate silver concentration of 0.05 mg/l (high).

Site Number: 0719

Site Name: Delafield, Delafield, WI

Site Type: Clay lined

Total Design Volume (million cubic yards): 1.0

Principal Waste Types: MSW

Date Filling Began: 1975

Site Size (Acres): 13

- Highest total kjeldahl and ammonia nitrogen concentrations (over 1,000 mg/l)
- Refuse up to 50 feet deep

Site Number: 1099

Site Name: WMI-Metro, WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 9.0

Principal Waste Types: MSW, IND, HAZ

Date Filling Began: pre-1970

Site Size (Acres): 96

- Leachate chloride concentrations in excess of 4,000 mg/l (possibly due to refuse depth).
- Arsenic analysis exceeded drinking water standard of 0.05 mg/l (maximum concentration of 0.059 mg/l).
- Leachate barium concentrations exceeded the drinking water standard of 1 mg/l.
- Chromium concentrations above 1.5 mg/l.
- Leachate nickel concentration exceeded 1 mg/l.
- Leachate aluminum concentration of 85 mg/l.
- Methylene chloride concentration of 20,000 mg/l exceeded the ambient water quality standard for the noncarcinogenic effects of methylene chloride which is 12,400 mg/l.
- Detectable concentration of PCB-1016 was found - 2.8 µg/l.
- Herbicide 2,4-D was found - 1,800 µg/l - Primary drinking water standard is 100 µg/l.
- Maximum leachate concentrations exceeded all the primary drinking water standards in at least one instance.

Site Number: 1678

Site Name: WMI-Omega Hills, WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 15.0

Principal Waste Types: MSW, IND, HAZ

Date Filling Began: 1971

Site Size (Acres): 166

- Large co-disposal site.
- Leachate oxygen demand medians greater than 20,000 mg/l.
- Highest total kjeldahl and ammonia nitrogen concentrations (over 1,000 mg/l).
- Leachate chloride concentrations in excess of 4,000 mg/l (possibly due to refuse depth).
- Highest chloride concentration of 11,375 mg/l.
- Leachate sulfide range of <1 to 7.2 mg/l.
- Arsenic analysis exceeded drinking water standard of 0.05 mg/l one value of 70.2 mg/l, next highest 1.05 mg/l).

- File records indicate pesticides were disposed of here.
- Leachate barium concentrations exceeded the drinking water standard of 1 mg/l.
- Chromium concentrations above 1.5 mg/l.
- Leachate lead concentrations typically greater than 0.3 mg/l and potentially as high as 10 mg/l.
- Leachate silver concentration of 0.083 mg/l (high).
- Highest beryllium concentration.
- Leachate nickel concentrations exceeded 1 mg/l.
- Halogenated ethers and aliphatics detected more frequently than the other sites.
- Higher values of phenol.
- The maximum leachate concentrations exceeded all of the primary drinking water standards in at least one instance.

Site Number: 1739

Site Name: MWI - Pheasant Run, WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 1.6

Principal Waste Types: MSW, IND

Date Filling Began: pre-1967

Site Size (Acres): 35

- Arsenic analysis exceeded drinking water standard of 0.05 mg/l (maximum concentration: 1.29 mg/l).
- Chromium concentrations above 1.5 mg/l.
- Leachate lead concentration in excess of 2 mg/l.
- Leachate selenium concentrations exceeded 0.1 mg/l (high value of 1.85 mg/l).
- Leachate silver concentration of 0.07 mg/l (high).
- Copper concentrations exceeded drinking water standard of 1 mg/l.
- Maximum leachate concentrations exceeded all of the primary drinking water standards in at least one instance.

Site Number: 2358

Site Name: Fond du Lac Co., WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 0.5

Principal Waste Types: MSW, IND

Date Filling Began: 1978

Site Size (Acres): 16

- Wide variability in leachate specific conductance over time

Site Number: 2484

Site Name: Outagamie Co., WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 3.2

Principal Waste Types: MSW, IND

Date Filling Began: 1975

Site Size (Acres): 47

- Reduction in initially high BODs of 6,000-8,000 mg/l to highs typically less than 5,000 mg/l.
- High BOD values each year in the spring or summer.
- Patterns of leachate oxygen demand complicated by operational conditions.
- Median chromium concentrations above 0.2 mg/l.

Site Number: 2568

Site Name: Brown Co. West, Green Bay West, WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 4.0

Principal Waste Types: MSW, IND

Date Filling Began: 1977

Site Size (Acres): 50

- Had detectable concentration of 1,1-dichloroethane.
- The 1,2 isomer of dichloroethane was detected.
- Xylene detected (one of 2 sites tested).

Site Number: 2569

Site Name: Brown Co. East, Green Bay East, WI

Site Type: Clay lined

Total Design Volume (million cubic yards): 6.0

Principal Waste Types: MSW

Date Filling Began: 1976

Site Size (Acres): 30

- Leachate aluminum concentration below 1 mg/l
- Detectable concentration of 1,1-dichloroethane
- Xylene detected (one of 2 sites that were tested)

Site Number: 2575

Site Name: WMI-Ridgeview, WI

Site Type: Natural Attenuation

Total Design Volume (million cubic yards): 0.8

Principal Waste Types: MSW, IND

Date Filling Began: 1976

Site Size (Acres): 17

- Median chromium concentrations above 0.2 mg/l

Site Number: 2627

Site Name: City of Superior, WI

Site Type: Zone-of-saturation

Total Design Volume (million cubic yards): 0.6

Principle Waste Types: MSW, IND

Date Filling Began: 1976

Site Size (Acres): 20

Site Number: 2680

Site Name: Dane Co., WI

Site Type: Natural Attenuation

Total Design Volume (million cubic yards): 1.5

Principal Waste Types: MSW

Date Filling Began: 1977

Site Size (Acres): 49

- Specific conductance can be as high as 19,000 umhos/cm.
- Dissolved solids - strongest leachate, from headwell.
- Leachate oxygen demand medians greater than 20,000 mg/l.
- Leachate headwell in 20 feet of refuse.
- The well is a source of undiluted leachate since the leachate is not collected, it remains in contact with waste for a long time. The leachate strength is therefore slowly increasing, and leachate is very contaminated.

Site Number: 2821

Site Name: Eau Claire Co., Seven Mile Creek, WI

Site Type: Clay lined

Total Design Volume (million cubic yards): 1.2

Principal Waste Types: MSW

Date Filling Began: 1978

Site Size (Acres): 24

- Wide variability in leachate specific conductance over time

Site Number: 2822

Site Name: City of Janesville, Janesville, WI

Site Type: Clay lined

Total Design Volume (million cubic yards): 0.7

Principal Waste Types: MSW, IND

Date Filling Began: 1978

Site Size (Acres): 18

- Increase in concentration of oxygen-demanding material in leachate over years.
- Leachate barium concentrations exceeded the drinking water standard of 1 mg/l.
- Leachate aluminum concentration below 1 mg/l.
- The 1,2 isomer of dichloroethane was detected.
- Pesticides detected: 4.6 µg/l of delta-BHC.

Site Number: 2892

Site Name: Marathon Co., Marathon, WI

Site Type: Clay lined

Total Design Volume (million cubic yards): 1.5

Principal Waste Types: MSW, IND

Date Filling Began: 1980

Site Size (Acres): 10

- Increase in the concentration of oxygen-demanding material in leachate over the years.
- Site with one of the lowest leachate nitrogen (200-500 mg/l).
- Higher % levels of organic nitrogen.

Site Number: 2895
Site Name: WMI - Muskego, WI
Site Type: Clay Lined
Total Design Volume (million cubic yards): 1.3
Principal Waste Types: MSW
Date Filling Began: 1980
Site Size (Acres): 29

- Leachate barium concentrations exceeded the drinking water standard of 1 mg/l.
- Highest concentration of silver.
- Detectable concentration of 1,1-dichloroethane.
- Phenol values from 39 to 350 µg/l were detected.